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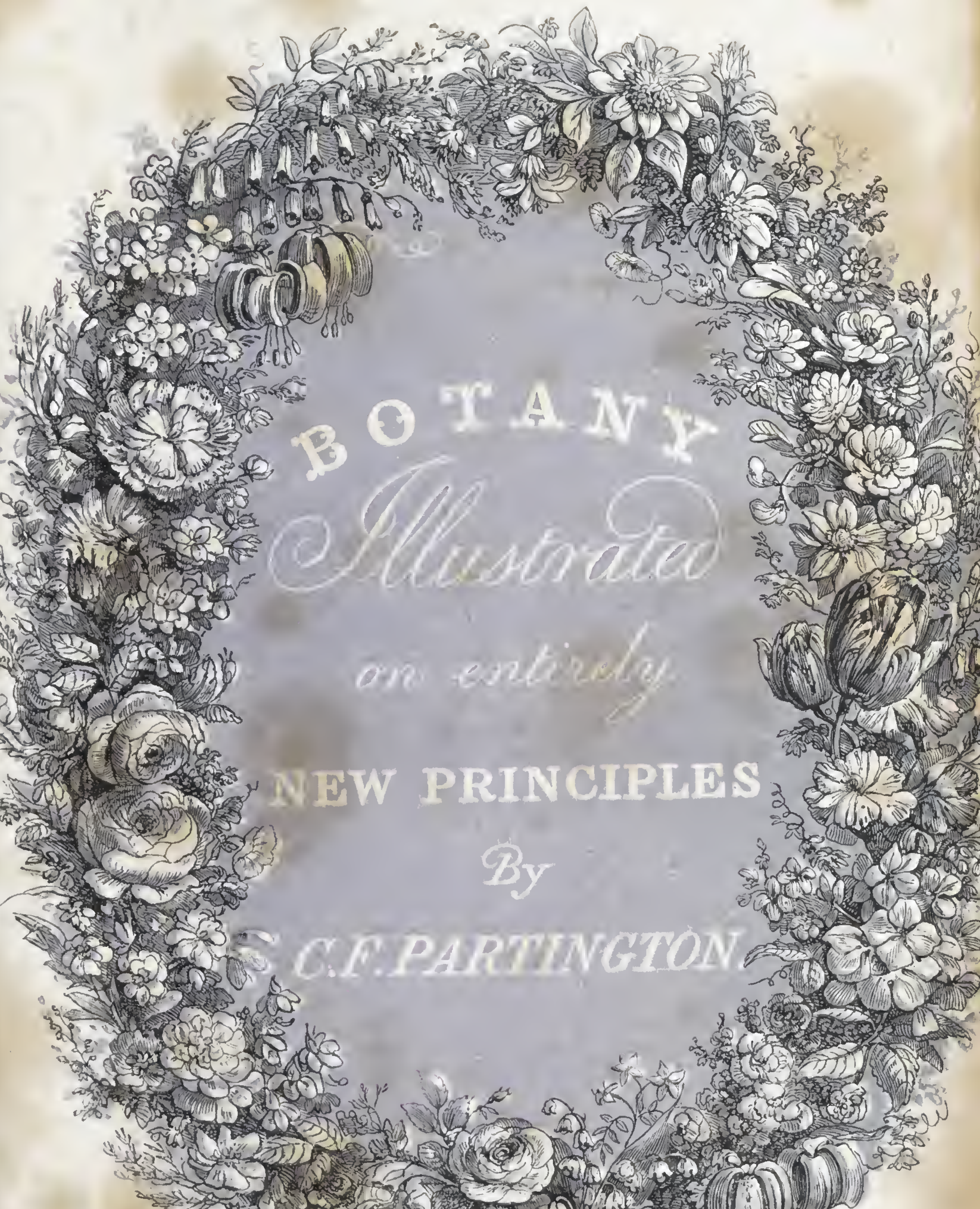
PASSION FLOWERS
Passiflora
Passiflora Kermesina



ENGRAVED & PRINTED BY G.W. BONNER.

INTRODUCTION

TO THE

SCIENCE OF BOTANY;

Illustrated,

ON AN ENTIRELY NEW PRINCIPLE,

BY A SERIES OF HIGHLY FINISHED

DELINEATIONS OF THE PLANTS,

COLOURED TO REPRESENT NATURE;

INCLUDING

Characteristic Details

OF THE PHYSIOLOGY, USES, AND CLASSIFICATION,

OF THE VEGETABLE KINGDOM.

BY CHARLES F. PARTINGTON,

AUTHOR OF VARIOUS SCIENTIFIC WORKS, AND EDITOR OF
"THE BRITISH CYCLOPÆDIA," &c.

LONDON:

HARVEY AND DARTON, GRACECHURCH STREET,
AND ORR AND SMITH, PATERNOSTER-ROW.

M.DCCC.XXXV.

INTRODUCTION.

The rapidly increasing desire now exhibited for obtaining useful information illustrative of the vegetable kingdom, forms a distinct era in the progress of the natural sciences. Popular botany scarcely existed prior to the commencement of the present century, and yet we now find a variety of treatises on the subject, which deservedly place their authors high in the ranks of literary eminence. While, however, books have multiplied for the use of individual students, there is not one properly illustrated work which will assist the teacher in the boudoir or lecture room in the important task of

imparting elementary knowledge to others. And, surely, the spread of truths which place the unsearchable wisdom and goodness of our Creator in the strongest point of view, must be an object to be desired by all those who would direct the young and ingenious mind to the paths of future excellence. Those indeed who, at any period of their life, would commune with their Maker, cannot do so with more advantage to themselves than in the theatre of his works.

But nature, though ever wonderful and abounding in illustrations of that holy word which in the olden time taught mankind to go to the "lilies of the field" for a practical illustration of the goodness and unceasing care of the Creator — Nature, though thus interesting, is not ever blooming; and as the faculties of sentient beings do not re-

main dormant even during the chilling blasts of winter, like those of hybernating animals, it has become necessary for those who would read the kingdom of nature to do so through the medium of the graphic art. Now, to do this with advantage, the Author has appended to the present work some of the most interesting illustrations in a form as nearly allied to their natural character as possible.

One great advantage which results from this mode of imparting knowledge, will be found in the permanence as well as beauty of these embellishments, which, whilst they serve to adorn the temple of instruction, really form a "golden road" to the acquirement of botanical science. The flower-garden is always a valuable adjunct, but yet, as we have already stated, it must be obvious that the necessary flowers can

neither be procured at all seasons, nor yet in any season in some localities; and even when obtained how fragile and evanescent are their beauties.

> " The flowers which grace their native beds,
> Awhile put forth their blushing heads;
> But, ere the close of parting day,
> They wither, shrink, and die away;
> But these, which mimic skill hath made,
> Nor scorched by suns, nor killed by shade,
> Shall blush with less inconstant hue.
> Which art at pleasure can renew."

Those, however, who can go to nature will do well to avail themselves of her richly garnished storehouse, as she produces in abundance those plants which are best fitted for the illustration of her mysteries; and in that case the present little volume may form a useful assistant to the botanical student, as one feature peculiar to these Lectures is, that every effort has been

made to strip botanical science of its technicalities, and of those abstruse terms which serve rather to astonish and confound than to induct the inquirer into the temple of science. But there is another feature which though not so prominent to the eye, has never been lost sight of. In studying the works of *Nature,* we have never lost sight of its great *Parent*, and have shewn, by direct reference to the Vegetable Kingdom, that there is nothing too minute to exhibit the infinite Wisdom and Goodness of the Creator. In this respect there is not

> "———— A tree,
> A plant, a leaf, a blossom, but contains
> A folio volume. We may read, and read,
> And read again, and still find something new,
> Something to please, and something to instruct."

[The characteristic coloured Embellishments published to illustrate this work, and which are especially adapted for teaching the science of Botany, are described at page 137, and may be procured separate from the Volume, at the Publishers'.]

COMPLETE INTRODUCTION

TO

THE SCIENCE OF BOTANY.

LECTURE I.

RISE AND PROGRESS OF THE SCIENCE OF BOTANY.

A SCIENTIFIC acquaintance with the vegetable kingdom now forms an essential portion of human knowledge; and systematic botany, which, even in the last century, was little more than a dry detail of abstruse terms, without either instruction for the student, or interest to the general admirer of this beautiful portion of natural history, has now become a most delightful subject of scientific research. In the present day we do not, as in the olden time, merely catalogue the names of the plants that surround us, but the botanist becomes acquainted with their attributes and properties; neither is the study of the vegetable

kingdom an isolated science, as it forms a part of the philosophy of the universe; and we see the hand of creative goodness as clearly in the wonderful organisation of the humblest lichen, as in the towering luxuriance of the cedar which "o'ershadoweth the mountain."

Some writers have affirmed that botany is valuable only to the naturalist; but a very brief examination of the science will serve to shew that the data on which it is founded should be taught amongst the first principles of utilitarian knowledge, as there is scarcely a plant on the face of the earth that may not in some measure be made available in supplying the wants of man.

Botany, in its most extended sense, is that branch of the history of nature which relates to the vegetable kingdom; and, as a science, it may be said to include the physiological character and properties of plants, as well as their description and classification. It is usually divided into two parts; the one relating to the physiology of plants, and the other to their systematic arrangement. That part of the science which refers to a description of the organs which constitute a plant, and the classification of plants by their exterior characters, is termed *systematical* botany; while

the structure and functions of plants belong to the *physiological* part of the subject.

Botany may be considered as old as the creation, as man's earliest studies would evidently be directed towards the plants and trees from which he was to derive shelter and nutriment; and, since nature has so bountifully bestowed her blessings on the earth, we cannot be surprised that her numerous beauties and excellences should have, in an especial degree, excited the attention of man. We are told in Holy Writ that our first parents were supplied by the spontaneous vegetable productions of the earth; and we find man, at a later period, represented as "a tiller of the ground." The next step in practical botany was to produce from the vegetable kingdom not merely the comforts of life only, but the luxuries which result from a combination of practical with scientific knowledge, as the same veritable authority informs us that Noah became "a husbandman, and, having planted a vineyard, drank of the wine."

Passing on to the time of Solomon, it appears that that wise monarch, amongst the cares of state, found leisure to make an extensive catalogue of the vegetable productions of the earth.

In Chaldea, botany was only made subservient

to medicine; which was also the case in Egypt. Passing, however, from that oasis of learning, as well as of natural fertility, we come to Greece; and here Aristotle appears to have been the earliest of the philosophers of that country who made any really scientific inquiries into the economy of vegetation. He is said to have written two botanical works, the substance of which are still preserved in the writings of Theophrastus; so that, if Aristotle is to be considered as the founder of the philosophy of botany, the adaptation of his opinions to practice is, as far as we know, to be ascribed to his friend and disciple. Such was the fame of Theophrastus, that, when his master retreated to Chalcis, he succeeded to his school, whither no less than 2000 disciples repaired. In his *Historia Plantarum*, he described all the plants which were known in his day, either by description or actual observation. The text of that part of his work which has descended to our days is remarkably corrupt, but much light has been thrown on it by the critical acumen of the learned Sprengel. No order is pursued in arranging his descriptions; the same name is often bestowed on extremely different plants, and his opinions upon abstract matters do not seem to

have been different from those of Aristotle. He was a believer in the transmutation of species, and even of genera, and treats largely upon the subject. His nomenclature of the parts of plants is the first upon record in which an attempt was made to attach precise ideas to particular terms; and in this he succeeded remarkably well. The physiology, or "physic" of trees, was understood by him in a manner which necessarily gives us a high opinion of the state of philosophical knowledge in his day. He distinctly pointed out the difference between the structure of the trunks of palms and other trees. He also discovered that nutrition was conveyed to plants through their leaves; but he attributed this power to both surfaces alike. The sexes of plants were not unknown to him; but his ideas on the subject were incorrect. In short, that part of his history which considers vegetable physiology offers a mass of observation and reasoning, which is well worthy of attention even at the present day.

When the Romans became masters of Greece, they adopted the writings and opinions of the latter country so servilely, that they added but little additional theoretical information to the science. The first direct evidence of any bota-

nical inquiry among this people, is that which is furnished in the works of Dioscorides and Pliny: but, though these philosophers were long considered as the best and most infallible guides in the study of plants, botany derived from their labours but little advantage; and the laudable example which they set seems to have been as much neglected by the Romans as that of Theophrastus was among the Greeks; for it was permitted to lie, like all other departments of science, buried in the ignorance and barbarism of the darker ages, except in as far as it was cultivated by Galen, Avicenna, and a few other Asiatic Greeks, till the period of the revival of learning in Europe.

With the revival of learning in the fifteenth century, we find botany beginning to assume a new character; and the first accurate figures of plants were employed to illustrate a scientific work from the pen of Brunfelsius. He was succeeded in the march of improvement by Bock, Cordus Fuschius, Dodonæus, and Clusius; all natives of Germany. In Italy, the celebrated Mathiolus was the first to cherish returning science; in France, Delachamp and the elder of the Bauhins endeavoured to embrace in one

comprehensive view the whole of the vegetable kingdom; and in our own country, Turner and Gerard gave most decided proofs of their zeal and interest, by the publication of their herbals.

Gesner and Cæsalpinus were the first to prepare a classified view of the vegetable kingdom. Gesner considered that this might be best effected by dividing plants into classes, orders, and genera, according to the peculiar character of the flower. This important step was followed by an inquiry into the true principles and phenomena of vegetable life, by Grew and Malpighi; the latter an Italian, and the former an English physician. The result of the investigation of these illustrious phytologists was first communicated to the public towards the end of the seventeenth century; and it must be confessed, that the success of their labours made amends for the long neglect of preceding naturalists: for, though they had no track to direct them in this obscure and intricate investigation, yet, by joining patience to penetration, and experience to philosophy, and by adopting the only sure means of detecting the secrets of nature—the experimental mode of inquiry,—exploring most scrupulously the internal and recondite structure of plants, and watching

with unwearied application the functions of the various organs, they succeeded in removing much of the veil which had previously enveloped the phenomena of vegetation, and in opening to the observation of man a new view of the works of God.

The path which had been pursued with so much success by Malpighi and Grew, suggested the formation of a methodical classification of plants founded on their anatomical structure. Passing by the distinguished names of Morrison, Ray, Tournefort, Revinus, Boerhaave, and Herman, we come to the great founder of modern botany, Linnæus. His, however, was an artificial system; and, with every disposition to admire its simplicity and excellence, it must still be admitted that the Linnæan system possesses inherent defects, which will, however, be better understood when we come to examine the minutiæ of the science.

Next in order to those of Linnæus we must place the labours of the celebrated French naturalist, Jussieu. He purposed in his system to bring the genera of plants together as much as possible, according to their natural affinities; constructing his classification rather from an enlarged and general view of those affinities than from any technical characters previously assumed. It

may be proper to add, that his primary divisions were derived chiefly from the cotyledons, or seed-lobes of plants.

Since the appearance of Linnæus' and Jussieu's great works, botany has appeared under a more clear and interesting point of view; and the labours of Banks, Miller, Wildenow, Withering, Humboldt, Smith, Loudon, Main, Castles, Lindley, and a long list of contemporary naturalists, have tended to shed a bright halo round this interesting science. But the division of scientific botany which has made the greatest progress in modern times is that relating to the anatomy and physiology of plants, which has been very materially advanced by the aid of powerful microscopic instruments. Kingdoms within kingdoms are thus spread out before the eye of the observer; and the more we contemplate the extraordinary chain of harmonious adaptation which is thus offered to our view, the more we are led to praise the omniscient power which has formed such a series of wonders for our benefit and contemplation. In those instruments which are illuminated by the compound gasses, many plants that are invisible to the naked eye may be distinctly pictured on an artificial screen, and in some cases

the circulation of their fluids exhibited. Indeed, we cannot close this brief view of the history of botany without adverting to the advantages which result from a careful examination of the physiology of vegetation.

The study of the internal structure of a plant has many advantages over that of the anatomy of the animal kingdom; and, though it is scarcely possible to understand how any thinking naturalist can be an atheist, yet there are such unalloyed beauties to be admired, when we come to study the structure of vegetable bodies, that must of necessity lead the mind to a contemplation of the wondrous power which could transform mere earth into so extraordinary a fabric. In the human dissecting-room there is much to revolt the mind of the student. He contemplates the relics of frail mortality till he almost forgets that he is deriving instruction from the casket that has been formed in the image of his Creator. The divine spark has fled, and in its new and altered character he forgets the hand which fashioned it. But the flower is beautiful, even when cut from its parent stem; and the living vegetable may be examined and experimented on without the throb of pain being perceptible.

LECTURE II.

STRUCTURE AND USES OF THE STEM AND ROOT.

Having, in the previous Lecture, given a rapid sketch of the progress of botanical science, we may now proceed to describe the essential parts of a plant, commencing with the *root*. This is one of the most important appendages to a vegetable body. In the first place, it serves to attach it to its parent earth, or the soil from which it derives its principal sustenance; and, in the second, it absorbs a considerable portion of nourishment from the earth or other body in which the plant vegetates, and conveys it by means of the sap-vessels which pass up the stem through its whole extent. When we view the great height of some trees, and the extent of their foliage, it would, at first view, appear impossible to attach them to those soils that are of a loose and friable character. The cocoa, for example, is frequently found growing to an immense height in a sandy soil. Now, if we were to place the oak in such a situation,

it would immediately be uprooted; but the root of the cocoa is as well fitted for the soil in which it grows as its fruit is for the inhabitants of its native clime; and though the "monarch of the English forest" would be swept away by the blast of the tempest, the cocoa-tree remains firm and stable.* This security results from the compact way in which its smaller fibres are interlaced with the sand; and they may literally be said to embrace each other, forming one solid mass.

The oak, on the contrary, having to insert its

* The vegetable kingdom owes many of its advantages, both in an economical and natural point of view, to the great altitude of some of its families. Thus, the taller trees serve to shade the herbaceous plants, which would otherwise be destroyed by the intense heats of summer; and in the colder climates, the fir, the pine, and most of the resinous trees, afford, by the peculiar texture of their foliage, a valuable shelter from the rain and snow. The lofty trees, also, of those climates where artificial heat is most required, furnish a very excellent kind of fuel. It may be proper to add, that the largest trees are most abundant in a state of wild nature: this is especially the case in South America; and Humboldt affirms that, at an altitude of more than one hundred feet from the earth's surface, the foliage of these trees are so intimately interwoven with climbing plants, that nothing but the intervention of rivers and lakes prevents the smaller animals from passing over a species of living road many miles in extent.

ramified roots into earth of a more solid character, its fibres are proportionably stronger and longer; and its power of resisting the shocks of stormy and tempestuous weather has been thus beautifully illustrated by a popular poet:

> "As o'er the aerial Alps, sublimely spread,
> Some aged oak uprears his reverend head,
> This way and that the furious tempests blow,
> To lay the monarch of the mountain low:
> Th' imperial plant, though nodding at the sound,
> Though all his scattered honours strew the ground,
> Safe in his strength, and seated on the rock,
> In naked majesty defies the shock:
> High as the head shoots towering to the skies,
> So deep the root in earth's foundation lies."

Thus, then, we find that those soils which are but little adapted for the expansion of the root rarely produce trees of such an altitude as will need any very extended support beneath; so that nature invariably produces the most perfect equilibrium of forces.*

We have seen that the great majority of plants

* Many other instances might be adduced of this perfect adaptation which subsists between the form of the root and the soil in which it is intended to vegetate; especially in the greater portion of the bulbous-rooted plants, which, properly belonging to soft and watery soils, are formed with a flattened under surface, by which alone they are protected from sinking

derive their nourishment from the earth in which they are firmly imbedded; there are, however, many exceptions to this rule. Thus, we find the common duck-weed covering with its dense foliage the surface of stagnant pools, its roots hanging pendent beneath, and yet floating, like the gardens of Cashmere, without any fixed locality.*

The air-plant may be adduced as another instance of the absence of all earth-bound roots. Thus, several species of the *Ficus* have been known to live for years suspended in a greenhouse, and nourished only by the air and watery vapours which surrounded them. There are, also, many parasitical plants which receive no support from the earth, and the common ivy is frequently seen to derive the whole of its nutriment from the stem which it has deprived of vitality by its close embraces. But the air-plants of South America are by far the most extraordinary, for

to such a depth as would preclude healthful vegetation. Again; we see those plants which are furnished with a slender and piercing root, growing luxuriantly on a dry wall, and entirely supported by one or more long filaments inserted in the crevices between the bricks. Well might the philosopher of old exclaim, "How perfect is every thing in its kind!"

* The *Utricularia minor* is supported in the water by small bladders attached to the roots.

their luxuriance and beauty. They may be said to form an interminable canopy, partially supported by slender filaments from the vast trees that are indigenous to that climate. The orchis and pine-apple tribes furnish many of the most beautiful specimens of the air-plant.

The roots of plants differ no less in their duration than they do in their external structure; and in this respect they are admirably adapted to the wants of the vegetable. They are either of *annual*, *biennial*, or *perennial* growth. The first belong to plants which live only one year, as, for instance, the various sorts of grain: the second to such as are produced one season, and, living through the ensuing winter, produce flowers and fruit the following summer, as the shepherd's club,* and the still more common instance of the foxglove. Perennial roots are those which live through many successive seasons, as those of trees, and even many of the herbaceous plants.

We may now examine more in detail the various forms of the roots of plants, as they may be best divided for botanical illustration. The first and most simple form of root consists of a bundle of fibres, which serve to attach the vege-

* *Verbascum thapsus.*

table to the earth, and convey nourishment directly to the stem or leaves. This species of root is too well known to need any particular description, and it may be enough to observe that it is common in most of the grasses.* The *ramose*, or branched root, is of a more woody texture than the fibrous, and belongs to trees and shrubs.

The *spindle-shaped*, or tapering root, is well known from its furnishing some very valuable culinary vegetables. The carrot, radish, and parsnip, form familiar illustrations of this species of root. The spindle-shaped root acts like a wedge, and is enabled, by its peculiar formation, to descend a considerable depth in the earth, and yet, from its great size, furnish an abundant supply of farinaceous food. It may be proper to add, that this form of root is provided with a number of small fibres or radicles, which really imbibe the nourishment for the support of the plant.

* There is a modification of this species of root which acts a very important part in the economy of nature. It is usually called the *creeping root*, and has a subterraneous stem, which branches off horizontally and throws out fibres in every direction. A proper use of sea-side grasses of this character has, in many cases, served to check the encroachments of the waves on some of the most exposed coasts of Holland and our own island, by binding down the sand.

The *tuberous root** consists of a series of fleshy knobs, varying in form and connected by common stalks or fibres. The potato and Jerusalem artichoke† form sufficiently obvious specimens of this kind of root. These knobs are sometimes of annual, at other times biennial growth, and in some instances they are perennial. In the *Orchideæ* of Europe they are mostly biennial; and their roots generally consist of a pair of oval or globular bodies.

The *bulbous-rooted* plants come next in order, and they comprise many of the most elegant varieties in the vegetable kingdom. They are usually divided into three very well defined classes. The first of these is solid, of which an instance occurs in the crocus. In other cases they are tunicate, as in the onion, where we find the entire bulb consisting of a series of concentric layers enveloping each other. In the third form, the root is composed of fleshy scales connected only at their base, and of which we can have no better example than that of the *Lilium superbum*. These bulbs are provided with fibres that may in reality be called the true roots; as the upper and more

* *Radix tuberosa.*

† *Solanum tuberosum* and *Helianthus tuberosus.*

massive part is really employed as the cradle of the future stem and flower.

The *granulated root* comes next in order. It consists of a series of granulations or bulbs, each group having their own proper fibres for the supply of nourishment; a very distinctly formed instance of which occurs in the white saxifrage.* In this case, as in that of the tuberous roots already described, nature ensures a sufficient supply of nutriment to the plant by an extended division of the groups which compose the bulbs.†

We have thus, in the simplest terms, illustrated

* *Saxifraga granulata.*

† Graphic delineations of the roots which have thus been described are given in the above sketch, commencing with the tuberous root on the left. We then proceed to the bulbous root, which is followed by the granulated and knobbed forms; and the last in the series is the spindle shaped root, of which a giant type is furnished in the *mangel wurzel,* or root of scarcity.

the base or primary support of the plant; the superstructure of stem and branches must next be examined. The organs of respiration, as well as those of reproduction, require a certain elevation above the earth-bound root, which serves to attach them to the soil they inhabit. By the aid of the *stem* the various parts of the plant derive an important portion of nutriment in the higher regions of the air, and the plant is thus enabled to avail itself of the revivifying principles of the atmosphere in the most advantageous situation.

Linnæus applied the word trunk as a general term for all stems, but the mode of division adopted by modern botanists is far more correct and applicable. They have been separated into six divisions, comprising trunks, stalks, straws, scapes, fronds, and stipes. The *trunk* is the proper stem, both of trees and shrubs; and is characterised by its height, size, and woody structure. Trunks are perennial, generally naked at the lower part, and divided and subdivided so as to support the leaves and flowers by the intervention of branches and twigs. By the term *stalk* we understand the stem of herbaceous plants only. They are rarely woody, and live but for one or two years in the ordinary growth of the plant.

A hollow tube, or *straw*, is the peculiar stem of grasses, rushes, and other similar plants. They are either entirely hollow or partially filled with pith, and generally divided into compartments by a species of knot or joint. Wheat and barley form familiar examples of this species of support.

A *scape* is that kind of stem which arises from the root and supports the flower, but not the leaf. Scapes are always herbaceous, and are either simple, or bearing one flower only, as in the primrose, or divided and many-flowered, as in the cowslip. The snow-drop, the daisy, the lily, and the hyacinth, are furnished with scape stems.

The *frond* is a peculiar kind of stem, in which the flowers and fruit are produced from the leaf itself. The frond is more especially connected with the fern and lichen tribes. The appellation of *stipe* is applied to the stem of ferns, palms, fuci, and fungi. Their figure is in general cylindrical, but sometimes expanded in the middle.

Passing from this brief view of the various forms of stems, as they occur in vegetable organisation, we may now examine the structure of a complete stem; and we shall soon see that the trunk of a tree, as it rears itself majestically in the forest, though its structure is less complex, is

scarcely less wonderful than that of the frame-work in the human structure. We may commence with the *cuticle,* or external covering. One of the most important uses of the cuticle is to admit the free passage of fluids from within as well as from without; and the pores, by which this is effected, vary according to the character of the plant: indeed, they admit of a ready absorption of fluids, while they perspire or throw off moisture but slowly. Familiar examples of this remarkable property may be found in the aloe, *Cactus*, and *Mesembryanthemum*, either of which, when cut from the plant, will remain for days, in the hottest season of the year, without any material alteration in its appearance, but which, when shrunk, will rapidly absorb moisture from any neighbouring body. Such plants are, accordingly, destined to inhabit hot sandy countries, where they are long exposed to the burning sun, with very rare supplies of rain. This part allows, also, of the passage of air, as is proved by experiments on the functions of leaves. Light probably acts through it, as the cuticle is a colourless membrane.

In those plants which require an equable temperature in a very variable or cold atmosphere,

the cuticle is clothed with hair or wool, and then it forms a very efficient covering.* The cellular integument lies immediately beneath the cuticle, and is, generally speaking, in a healthy plant, of

* The cuticle of a plant differs as much in its general character as does that which encloses the body of an animal, and yet in every case is it peculiarly adapted to the habits of the vegetable body. Thus, we find some of them covered with a complete armour of flint, an example of which may be adduced in the common cane; and the *Equisetum hyemale*, or Dutch rush, is surrounded with a toothed cuticle, formed like a smooth file, and actually used to a considerable extent for the same purposes. Other plants are protected from the rain by a simpler mechanism. Thus we find on the plum, and many other fruits and leaves, a dry powder covering the cuticle; this is a resinous exudation, and the rain passes over it in large drops without wetting the plant. A nearly similar effect is seen on the leaf of a rose during a passing shower; and the poet beautifully asks,—

"Hast thou not seen two drops of dew
The rose's velvet leaf adorn—
How eager their attraction grew
As nearer to each other borne?"

In the common maple, as well as in the cork-tree, the cuticle consists of a fungous mass resembling the cuticle of the hippopotamus and some other animals. The cuticle of many plants is extended into the form of hairs, of which examples may be adduced in the betony and nettle; and it is well known that the cuticular spines of the latter plant contain a poisonous fluid, which is given out on the slightest pressure.

a green colour. The stems and branches of both annual and perennial plants are invested with it; but in the woody portions of a tree it dries up, and is continually reproduced, the old layers which remain being forced outwards, and eventually becoming portions of the rugged covering of the tree.

The whole external covering of a tree is frequently called its bark; but the *liber*, or true bark, is really placed much nearer the wood which forms the great mass of the tree. The number of layers is said to depend on the age of the tree; so that each succeeding year, as a new filament is formed in contact with the wood, the layer which belonged to the previous year is pushed outwards, and becomes a species of dry crust adding to the bulk of the tree, and forming a residence for innumerable tribes of insects.*

The bark of a tree possesses many chemical properties which are applicable in the useful arts. The value of the oak-bark for the purposes of

* It may be proper to state that the thickness of the bark of a plant offers no very decided criterion as to its age, as the common carrot, which is a spindle-shaped plant, and but of one year's duration, is provided with a barky covering which forms the greater part of the root.

tanning is well known; and the "Jesuit-bark," so called from its medicinal uses, which were first discovered by a member of that religious order, have deservedly placed it high in the list of febrifuge remedies. The resin of the fir is also placed in this part of the tree, as well as the highly aromatic oil of the cinnamon. In many parts of the world the most beautiful articles of female attire are made from the bark of a tree; and the mezereon, a native of Jamaica, is so peculiarly distinguished in this respect, as to have its beautiful white and shining covering placed in our cabinets, under the name of *lace-bark.*

If we suppose the whole of these coats to be removed, we come at once to the *wood*, which forms the principal portion of a tree. It consists of a series of nearly concentric layers, differing in their extent and solidity; and it often happens that all the layers are broadest towards one side of the tree, so that their common centre is thrown very much out of the actual centre of the trunk. The wood owes its strength to innumerable ligneous fibres, and consists of various vessels, running for the most part longitudinally, some having a spiral coat, others not. Of these vessels, some, in their youngest state, convey the sap from the root to

the extremities of the fibres and leaves, others contain the various secreted juices, others, perhaps, contain air; and the whole are joined together by the cellular substance already described.

Experimental observations have shewn that the solid portion of a tree consists of an outer stratum of living wood, called the *alburnum*, or sap-wood, and an inner portion, called heart-wood. The alburnum forms the principal channel for the sap, which appears to ascend direct from the base, and then passes into the leaves, where it undergoes considerable changes; but the nature of these, and the chemical secretions of plants, will be more fully discussed in a future lecture.

There are various modes of accounting for the ascent of the sap, but the most probable is that which supposes it to result from the joint action of capillary attraction and the expansion of the various parts of the growing vegetable. It may be proper to add, that microscopic observations made on the *Chara* sufficiently prove that there exists counter currents in the motion of this important fluid.

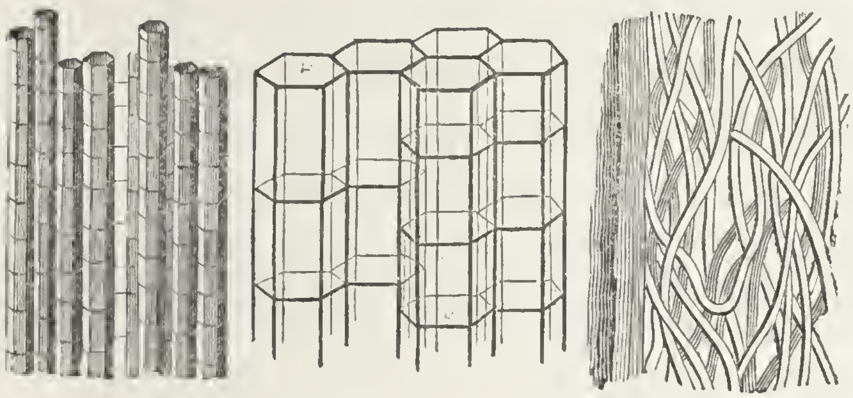
In the centre of most plants the eye may distinctly trace the situation of the *medulla*, or pith, and this substance is found in the greatest perfec-

tion in those parts which are most fully endowed with vegetable life. The position and character of the pith may be best illustrated by a reference to the elder.* In the spring the young shoots are of a green colour; but when the same shoots are fully grown it assumes a dry, white, and distinctly marked cellular character. In the stems of some annuals the pith, though abundant and juicy in the early stages of the plant, ultimately becomes little more than a web lining the hollow of the matured stem. Of this an example occurs in the common thistle. Although the apparent use of the pith is to strengthen the young shoot, and to act as a duct or reservoir of moisture, its cavernous structure shews that it is also intended to contain air, which may act expansively, and tend to enlarge the size of the stem. There seems, however, to be little vegetable action in the pith after the first year, for as the plant increases in age the

* The pith is by far the lightest part of the stem; and, owing to this circumstance, it has been employed for several purposes in the useful arts. The value of pith for illustrating the phenomena of electricity is such, that we could neither conveniently exhibit the passage of this subtle element, nor the operations of the mimic lightning, without this useful vegetable adjunct.

pith decreases in volume, and in old stems becomes almost obliterated.*

The branches of a tree may be considered as minor divisions of the trunk. They originate, generally speaking, at least, in the upper extremity, but frequently in the whole line of its surface. The primary divisions are again subdivided into secondary or more slender stems; and this species of subdivision continues to go on, till they ultimately become the most minute rami-



* The fibrous character of a large part of the stem, as delineated in a portion of the above sketch, admits of so firm a species of interlacing between the parts, that there is no other arrangement of organic structure which could communicate the same cohesion and elasticity as is thus given by the Great Architect of Nature by the simplest means. The exquisite symmetry of the hexagonal cells that are found in other parts of the vegetable structure are well delineated in the other portions of the above engraving, and their minute accuracy strongly reminds us of the mathematically arranged habitations of the bees.

fications of the plant: thus obeying the same laws as the bones and blood-vessels in the animal structure, which go on communicating strength and spreading vitality to ever part of the frame. A striking instance of the immense horizontal range of the branches of a full-grown plant, may be adduced in the calabash tree, which will extend over a diameter of more than a hundred feet. A still more extraordinary example may be presented in the Ficus Indica, or banyan tree, which has been known to extend over an area of nearly two thousand square yards:—

> "Branching so broad along, that in the ground
> The bending twigs take root; and daughters grow
> About the mother tree; a pillared shade
> High over-arched, with echoing walks between."

LECTURE III.

PARTS OF FRUCTIFICATION.

The humblest flower that grows is really a wonder of creation. Whether we view it simply as a temporary part of the vegetable whose use is the reproduction of the species, proceeding from the plant but to form a new race of vegetables; or, whether we look at it as one of those beautiful creations of a bountiful Providence, who, not content with ministering to our substantial necessities, "Hath made all nature beauty to the eye." Still, in either sense these gem-spots of Nature form a delightful subject for the study of a contemplative mind. But how much is this pleasure enhanced, if we call in the aids of science to assist us in examining the more obvious beauties of the vegetable kingdom. It will then be seen that every part of a flower, from the gaudily painted and expanded corolla, to the hair-like filament which serves for its fecundation, have all their obvious and essential functions to perform.

And here it may be advisable, at the very threshold of this part of our subject, to recommend the student to visit the wood and dale, as the best school for an acquaintance with practical botany. Each mead or hedge-row will furnish abundant materials for experimental investigations. What, indeed, can be more delightful than thus to walk with our Creator in the theatre of his works. The more we study them, the more we must admire their perfect adaptation to the truly god-like end of universal good. Indeed, there is not a season that will not afford an abundant harvest of practical knowledge to the inquiring mind. In this respect the lovely blossoms of spring are as interesting as the more matured beauties of summer; and we may commune as sweetly with the early snowdrop, when its flowers are bedecked with the frosts of winter, as when the eye rests on the richly tinted foliage of the autumnal months.*

We may now examine in detail the various parts of a flower, commencing with the corolla.

* Pliny considered the opening blossoms as a species of "arborescent joy," in bearing which they assumed a new aspect, and vied with each other in the luxuriance and variety of their colours.

This is not an essential part of fructification, though it is the common accompaniment of the plant, of which, indeed, it is the crowning ornament. It usually determines its colour; thus we say, that the rose is red, and the sunflower yellow, because they possess corollas of those peculiar colours.

The corolla usually consists of a certain number of petals, varying considerably in different plants. So that, if we take a common white lily, six white petals may readily be separated from the rest of the flower, and these constitute the corolla, which forms a beautiful protection to the more delicate parts of fructification.

Linnæus viewed the corolla as a species of wing-case, which served to waft the flower up and down in the air, thus forwarding the process of impregnation; and Springel has shewn that it is of the greatest service in directing insects to the plants from whence they may derive honey. One thing, at least, is obvious, that it furnishes them with a pleasant odour-clad bower as a resting-place, while they extract the sweets from the nectary. Indeed, we can scarcely conceive any more beautiful provision for containing the reproductive organs of a vegetable, than that

which is afforded by the external parts of the corolla. Its form is usually of the most beautiful and symmetrical character; varying from the smallest microscopic object to that of the gigantic *Rafflesia Arnoldi*.

The colour of the corolla evidently depends in some measure on the character of the plant, or the degree of heat required for the maturation of the seed; for we all know that a white surface reflects heat without absorbing it; and it is most probably on this account that we find the greater part of the plants which blow in the colder seasons of a very light colour. This is especially the case with the snowdrop, the lily of the valley, the hyacinth, and the narcissus, which blossom early in the spring. Dark colours, on the contrary, absorb heat without reflecting it; and as the white corolla serves to reverberate or reflect the heat to the seed vessels, so this tends to absorb the matter of caloric. Thus we find that a large portion of those flowers which grow in a state of nature during the heats of summer, are usually, like the poppy, of a dark colour. It may be proper to add, that the internal temperature of different coloured flowers differs considerably at the same period.

The corollas of some flowers furnish a great variety of colours at the same period of time. The lilac presents the most beautiful gradation, from the strongly marked purple bud to the nearly colourless petal. So that the plant is indeed,

> " —— Various in array, now white,
> Now sanguine, and her beauteous head now set
> With purple spikes pyramidal, as if
> Studious of ornament, yet unresolved
> Which hue she most approved, she chose them all."

Thus far the poet; but looking at the matter in a physiological point of view, it is most probable that these gradations of colour, by producing different degrees of temperature, especially adapt the corolla to the different states of the parts of fructification within.

In the centre of the corolla are placed the *stamens* and *pistil*. The first of these generally consist of a very slender thread called the *filament*, surmounted by the *anther*, or head, containing a powder called the *pollen*. The *pistil* is a very important part of the flower, and is readily distinguished from the stamens by the peculiar character of its summit, which is crowned by a sort of gland or knob.

By the combination of these parts, which, as we shall presently shew, vary considerably in different plants, the seed is fitted for the purposes of reproduction; and by a proper acquaintance with the uses of the above simple organs, we may very materially change the external character of the flower.

We have seen that the stamens usually consist of an anther and filament; but in some cases there are several anthers or knobs at the extremity of the elastic thread, a striking example of which may be adduced in the common *fumitory*,* which has three anthers to one filament.

The stamens are differently placed in different plants. Some are inserted in the receptacle that is underneath the ovary, or seed vessel, an example of which occurs in the *ranunculus;* others are inserted on the ovary, as in the *orchideæ.* In many cases we find them in the corolla; whilst a large portion are inserted in the calyx.

The pistil is divided into three parts, the *germen*, the *style*, and the *stigma.* The germen appears under a variety of shapes, and it is sometimes placed above the bases of the calyx and corolla, as in the strawberry; and at others

* *Fumaria officinalis.*

beneath, as in the apple, &c. The style is less important, being in some cases altogether wanting. The stigma may be very distinctly seen in most plants, and the lily and tulip furnish striking examples of its presence. In the primrose it consists of a round ball, and in other cases we find it variously lobed. When the flower is ripe we may generally distinguish a small orifice, moistened with a viscid fluid, which, as we shall presently shew, acts a very important part in the process of fructification.

The nectary, which contains or secretes honey, is, generally speaking, attached to the corolla; and even the least observant naturalists may have sufficient evidence of its locality in many plants, by watching the labours of the industrious bee. In some flowers, as the dead-nettle, the tube of the corolla contains the honey without any evident nectary. In the garden nasturtium* it is seated in the calyx, and in the passion-flower we find it placed in glands on the footstalks of the blossom. In many cases the honey gives some nutritive support to the parts of fructification, and we need hardly add, that it serves to supply the food for myriads of insects whose industry would shame

* *Tropæolum.*

the most active of the human species—an industry which is in this case so well directed, as not only to supply themselves with food, but also, as we shall shew in the next lecture, to assist most materially in the impregnation of the plant.

The *calyx* is that portion of a plant which forms the envelope of the corolla. It generally consists of one or more green leaves, termed sepals, but its tints frequently vary in their colour. Examples of the calyx may be found in almost every part of the flower-garden, as well as in a state of wild nature; but, in the cases of the primrose and moss-rose, they are very distinctly marked, both before and after the appearance of the petals.

As calyces display a considerable variety in their form, colour, and the number of their leaves, botanists have divided them into seven varieties; that is to say, the perianth, the fence, the catkin, the sheath, the glume, the veil, and the curtain.

The first of these, called the *perianth*, or flower-cup, is situated immediately below the corolla, and, if we except the difference of colour, might in some plants be supposed to form part of it. An example of this part of the flower may be found in the five green external leaves of the rose,

including their urn-shaped base. In some instances it retains its place till the fruit is ripe, but in others it falls even before the flower is fully expanded.

The *fence*, or involucrum, is a species of calyx peculiar to umbelliferous plants. It is placed below the common receptacle, and in many cases resembles a small leaf.

The *catkin*, or amentum, consists of a common cylindrical receptacle, beset with scales, each of which is accompanied by one or more stamens or pistils; so that the whole forms an aggregate flower. The fir and hop may be taken as examples of this species of calyx.

The *sheath*-formed calyx is very distinctly marked. It constitutes a very perfect covering for the infant bud, and then opens longitudinally. As an example we may take the snowdrop.*

The *glume* forms the calyx of the grasses and gramineous plants generally. The beard or *awn* belonging to this part of the plant is well known for its hygrometric properties.

The *volva*, or curtain, is the membranous covering of the fungus tribe, and is displayed to

* *Galanthus nivalis.*

great perfection on the common mushroom,* forming a ring encompassing the stalk.

One of the primary uses of the calyx is evidently to protect the infant flower, but in a few instances it forms a permanent depository for the reception and perfection of the seed.

Having thus described the corolla, with its calyx or cup, we may now enumerate the various modes of arranging and combining the petals, employed by botanists as an index to the endless variety of forms which occur in the vast storehouse of Nature. The different modes of flowering may be best described under a series of distinct heads.

The *whorl* is usually placed first in order. In this form of inflorescence the blossoms surround the stem of the plant, forming a species of ring; an instance of which occurs in the common mare's-tail.† In other cases they are merely on two opposite sides, as in the dead-nettle and common balm.

In the *raceme,* or cluster, we find a number of flowers placed at some distance from each other, each on its own proper stalk. We may in this

* *Agaricus campestris.* † *Hippuris vulgaris.*

case instance the common currant, though it may be proper to observe, that its colour forbids any strongly marked display of the arrangement of its parts.

A *spiked* inflorescence bears numerous flowers, arranged along one common stalk. A well-known and beautiful instance may be cited in the lavender.* The term *spicula* is almost exclusively applied to the grasses that have many florets in one calyx, the florets being arranged on a small stalk, constitute the spikelet. Wheat, rye, and barley may serve as apt illustrations of this species of inflorescence.

The *corymbus* is in fact but a variety of the spike; but the subordinate flower-stalks being longer as they descend on the spike, the surface of the entire group of flowers are nearly on a level. This is shewn in the *Spiræa opulifolia.*

The *umbel* is nearly allied to the above species of inflorescence; but in this case the flower-stalks or rays are nearly equal in length, and proceed from a common centre.

The *cyme* nearly resembles the umbel, with this exception, that the stalks which spring from

* *Lavandula spica.*

a common centre are afterwards subdivided, as in the elder.*

The *fascicle* differs from the corymbus in having a series of flower-groups placed on little stalks, and collected into a close bundle, nearly level at the top. The sweet-william furnishes a very perfect illustration of this kind of inflorescence.†

Having thus described the principal charac-

* *Sambucus.*

† In the above sketches we have given some of the most marked forms of inflorescence, as already described. The more we examine these beautifully-contrived organs for the propagation as well as protection of the vegetable kingdom, the more are we taught to admire the exquisite economy of

> " Nature, enchanting Nature, in whose form
> And lineaments divine, I trace a hand
> That errs not."

teristics of a flower, and the general arrangement of its parts, we may now advantageously examine the seed for which this beautifully painted mansion appears to have been mainly formed. It may hardly be necessary for us to state that plants, like animals, are, generally speaking, well fitted for the renewal of their species; indeed, we find it ordained by the Power which rules creation, that the various families of the vegetable kingdom should each "bring forth seed after their kind."

Generally speaking, the seed-vessel is visibly formed from the germen or base of the pistil, which, after the flower has performed its proper office, gradually expands in its dimensions, till it becomes fitted for the production of a new plant. The mode of impregnation will be explained in treating of the Linnean system; and we may at once proceed to examine a few examples of seed-vessels, commencing with one whose external character sufficiently marks its business in the economy of vegetation. The fruit of the common pea is admirably lodged and defended from the elements. The seeds are placed in a completely water-tight covering of vegetable parchment. Its glossy exterior at once resists the action of rain, and pre-

serves the seed in the earlier periods of its growth from the scorching effects of the sun's rays. It is called by botanists a *legume*,* and, in the language of natural history, is said to consist of two valves. The tamarind is a legume filled with sweet pulp, in which the seeds are lodged; but in many cases the legume is divided into cells, an example of which occurs in the purple dolichos.†

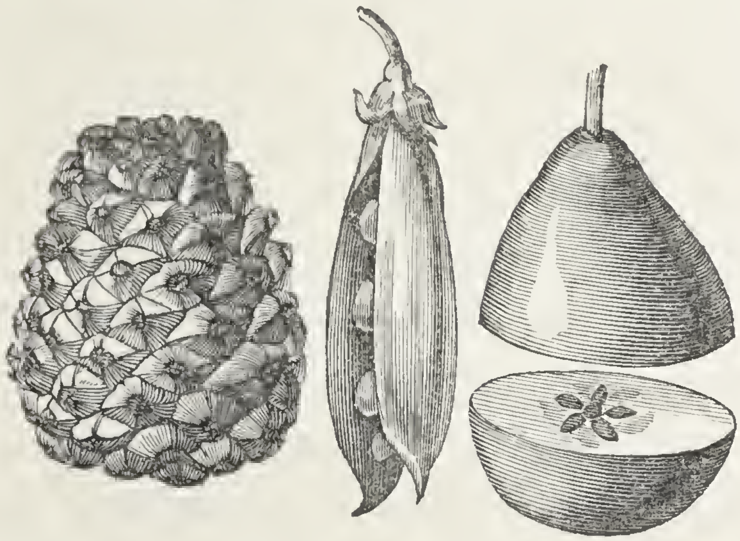
Of a very different character is the *cone*,‡ which, in every thing but colour, forms a species of mimic pine. In the most perfect examples of this kind of fruit, the seeds are closely sheltered by the scales, as by a capsule, of which the fir and cypress are examples. In the birch and alder they have a secondary capsule, all of which are peculiarly fitted for the protection of the seed.

The apple, pear, and other fruits of a similar character, form extraordinary illustrations of the compound yet simple processes by which the vegetable kingdom is perpetuated, and yet the wants of man supplied in the most advantageous way. This species of seed-vessel is called a *pome*. The husky part in the centre forming the core, is

* *Legumen.* † *Dolichos purpureus.*
‡ *Strobilus.*

a membranous capsule of five cells, in which are placed the seeds or pips.*

The *drupaceous* seed vessels are either of a



* The uses and physiological character of fruit will be illustrated n a subsequent lecture, and, in the present place, we must confine ourselves to graphic illustrations of those seed-vessels, already named, as some of the most simple yet curious in their character ; and it may be proper to state, that wherever circumstances have permitted, we have made a point of selecting the simplest and best known plants for our illustrations. We naturally love those associations of simple nature with which we have been earliest conversant, and can easily enter into the feelings of the young Otaheitan mentioned by Phillips, who, in the midst of the splendour of Paris, regretting the simple beauty of his native island, sprang forward at the unexpected sight of a banana tree in the Jardin des Plantes, embraced it, while his eyes were bathed in tears, and exclaiming, with a voice of joy, "Ah ! tree of my country !" seemed, by a delightful illusion of sensibility, to imagine himself for a moment transported to the land which gave him birth.

pulpy nature, containing a single hard nut, as in the case of the cherry, peach, plum, and the other stone fruits, or else the seed is contained in a bony shell, of which the almond nut may serve as a sufficient example.

The *berry* is a species of seed-vessel which is found to a great extent in wild nature, as well as in the various classes of cultivated plants. It is fleshy, and consists of one or more seeds enveloped with pulp. The currant, the gooseberry, the raspberry, and the dewberry, may serve as examples of this form of seed-vessel, though it may be proper to add, that the orange and lemon are in reality instances of true berries in a protecting rind or coat; whilst the fruit we call the strawberry is but a pulpy receptacle studded with naked seeds. In the fig the whole fruit is a juicy calyx, or rather common receptacle, containing in its cavity innumerable florets, each of which has a proper calyx of its own, that afterwards becomes pulpy and saccharine. Thus we find in every case the seed admirably protected, and the wants of man, as well as the lower classes of the animal kingdom, carefully provided for.

We may now suppose the various parts of a flower such as we have described, to have arrived

at a state of maturity, and the embryo plant fitted for its parent soil; it will next be advisable to trace the progressive changes which occur from the introduction of the dry seed into the earth to the full development of its powers as a plant. For this purpose it is in no shape necessary that the seed should be fresh gathered, as years—nay centuries have sometimes elapsed from the maturation of the fruit to its re-appearance as a living vegetable. Indeed, the long existence of the vital principle in seeds is one of those wonders of Nature which passes unregarded, solely because it is every day under our notice.

The seed of a plant usually consists of but three principal parts, which are termed the *cotyledon,* the *plume,* and the *radicle.* The first of these contains the matter essential for the early nutrition of the young plant. This, like the lacteous supply furnished to the animal kingdom, is provided for the support of life before those organs are expanded or developed, which afterwards support nature. The plume produces the stem and leaves, whilst the radicle becomes the root; but the cotyledon constitutes the great bulk of the seed, and its distinct formation may be well exhibited in the Windsor bean.

Some seeds are without cotyledons, and are hence called *acotyledones;* others have a single one, and are named *monocotyledones*, whilst those which have two are called *dicotyledones.* When beyond that number, they are sometimes denominated *polycotyledones;* and these distinctions, as we shall see when examining the various modes of classifying plants, materially affect their natural arrangement.

We may now suppose a ripe seed committed to the earth. This is usually effected in a cultivated vegetable, by placing it in an aperture beneath the surface, or else by scattering the seeds with the hand, and afterwards covering them with the soil.* It will soon be seen to swell by absorbing moisture from the surrounding earth, and if air be supplied, it speedily begins to vegetate. In the mean time, the external covering having performed its office in the protection of the seed, falls off and decays. The young root

* The preservation of the various tribes of vegetables which are found in a state of wild nature, is a most interesting part of their economy. In the common thistle we may see the embryo plant wafted on the wings of the wind, and, seemingly, the sport of every breeze; yet it ultimately finds a proper spot for carrying on the vegetative principle as certainly as in the well drilled plantation formed by the hand of man.

now descends, and the plant thus acquires a wider sphere of action, by which it can draw forth moisture and fix itself firmly in the ground. The leaf-bud then ascends, that the plant may receive the stimulus and support of an additional supply of atmospheric air. These opposite processes open to us a new page in the wonderful book of Nature, as the root of the young plant invariably tends downwards, whilst the leaves ascend; and Mr. Hunter shewed, by direct experiment, that the inversion of the earthy receptacle was no bar to the plant pursuing its ordinary course, as the fibres took a spiral direction when the earth was made to revolve.*

* Freedom of motion is evidently essential to healthful vegetation in any plant, so that a dry stony soil, by preventing the descent of the root, very materially checks the vegetative principle. The character of the soil must of course very materially depend on that of the plant; but if we would see those of a more prolific clime thriving in our own soil, we must carefully attend to the quality of the earth in which the embryo plant is placed, as few will vegetate in a sterile spot; and

> "—— Heath and rugged thorn,
> Shew the sad image of a soil forlorn."

Sometimes animal or vegetable manure is employed to feed the young plant, and they both give off carbon and hydrogen; but the mere existence of vegetable matter on the surface of

If we suppose the vegetative process to have gone on for some time, in the case of a common garden bean, the cotyledons, originally insipid and farinaceous, become sweet and mucilaginous; thus furnishing the proper materials for the support of the plant: and, if the bean be taken up in this stage, vessels will be distinctly seen which put forth their ramifications through every part of the cotyledon. As soon, however, as the plant has acquired a certain degree of vigour, the cotyledons either decay away or become a species of leaves; and then, as we have already stated, the plant depends on a compound apparatus of breathing leaves, and absorbent roots; the latter collecting materials from the soil, and the former from the atmosphere, which it does most effectually in those situations where light, air, and moisture are supplied with the greatest freedom.

Thus, then, have we traced this extraordinary process in its most familiar form; and it must be obvious that the mechanism by which it is accom-

a soil is not enough to constitute it a manure, as it must be reduced to a soluble state; to such a state indeed as will admit of its being absorbed by the growing vegetable. This is effected by fermentation and putrefaction. Hence the value of decayed dung and other matters of a similar character.

plished is as simple as the result is wonderful: so that a little earth, a little air, and a little water, properly amalgamated in the laboratory of Nature, and guided by the hand of Omniscience, effectually serve to ensure the resurrection of the plant.

LECTURE IV.

LINNÆAN SYSTEM, AND NATURAL CLASSIFICATION.

Having confined the preceding lectures as much as possible to the external characteristics of the vegetable kingdom, we may now proceed to examine the various systems that have been offered by scientific men for the general classification of the immense variety of vegetables with which our earth is studded.

The ancients appear to have made but few attempts at any thing like a general classification beyond a vague division of plants into trees, shrubs, and herbs; coupled with a reference to their places of growth and medicinal properties. The necessity for a scientific classification must, however, have been felt as soon as the number of known plants became considerable, and their relations and analogies obvious.

Early in the sixteenth century, we find botanical writers recommending a classification which should comprise the organs of fructification and

other essential parts of a plant, in contradistinction to those of an accidental or less determinate character. Some of the German and French botanists proposed to arrange plants by the various forms of their corolla; and Tournefort, who became very popular in the latter country, laid the foundation of a classification which was for some time generally adopted. His first great divisions consisted of herbs and trees, which were subdivided into those with a corolla and those without. The trees with a corolla he again distributed into such as have one or many petals, and those regularly or irregularly arranged. The corollas of herbs were divided into simple and compound; and another and more complicated division of the flowers was followed by a subdivision of the classes founded on the fruit. The whole of these vague and indefinite views were, however, swept away by the experimental investigations of Linnæus, who ultimately succeeded in establishing an artificial system, which still forms the basis of modern classification.

A knowledge of the sexual character of plants is, however, much older than the time of the distinguished Swede whose labours we are now about to examine; but the subject was not fully de-

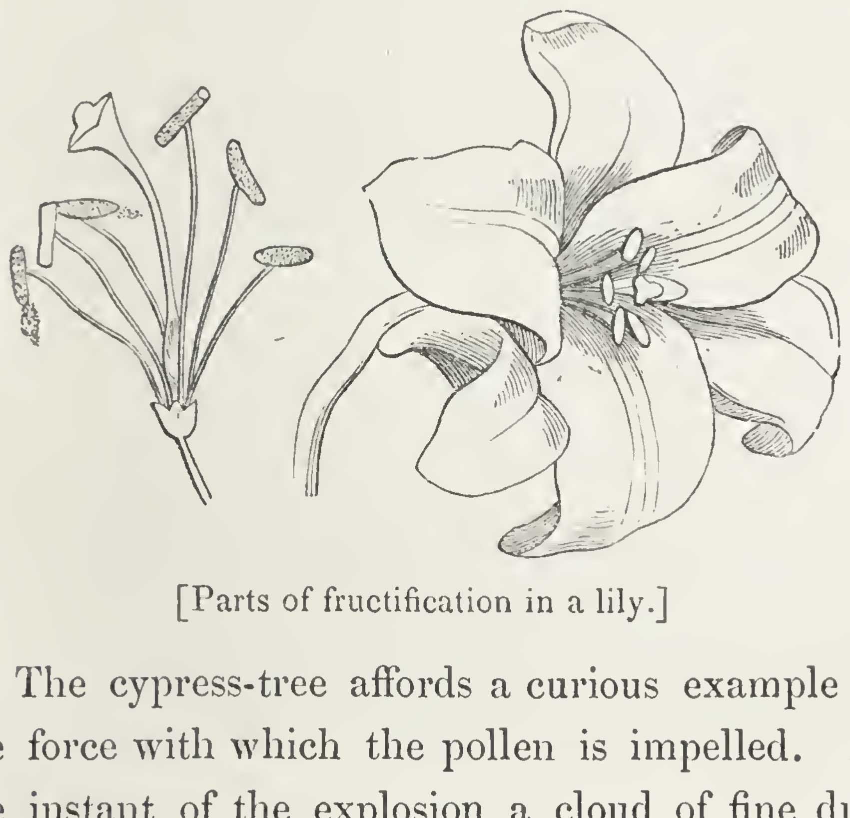
veloped till the year 1732, when Linnæus determined the functions of the stamens and pistils, and experimentally proved those organs to be essential to the reproduction of vegetables.*

We have already seen that the corolla of a flower when present, forms the most conspicuous envelope of the parts of fructification. These consist of a series of stamens, one or more pistils, and a receptacle. We may, however, best illustrate these parts, and exhibit the sexual arrangement which subsists between them, by taking a simple flower and dissecting it.

A lily has six stamens : these consist of slender threads crowned by an enlarged head or anther. The latter contains the pollen, consisting of a fine and brightly coloured yellow dust. Now the office of this dust is to fertilise the seed which is

* The real name of this illustrious naturalist was Linné. He was born at Roeshult, in 1707, and may justly be characterised as the Lord Bacon of Botany; for he sought out the mysteries of the natural kingdom, and illustrated his systematic views by experimental methods ; and he has reared a prouder monument to the glory of his native land than was ever built up by its most distinguished warriors. We have since had many botanists, many distinguished zoologists, as well as accurate entomologists; but none who, like him, could grasp the whole arcana of the natural kingdom.

effected by distributing it over the stigma of the pistil placed in the centre, and thus conveying it down to the ovarium. Many curious contrivances are resorted to in the economy of vegetation for effecting this object. The pollen is usually discharged from the anther in such a way as to ensure its falling on the adjoining pistil; and when the anther has given indications of maturity by the distended appearance of its cells, the valves of which these minute chambers consist become more and more indurated, till at last they fly open and at once discharge the pollen on the pistil.



[Parts of fructification in a lily.]

The cypress-tree affords a curious example of the force with which the pollen is impelled. At the instant of the explosion a cloud of fine dust

may be distinctly seen at a considerable distance from the flower, a phenomenon also very apparent when the male catkins of the birch-tree explodes. In the saxifrage the stamens lean one or two at a time over the stigma, retiring after they have shed their pollen, and then giving place to others. Another example of this beautiful and methodical process occurs in the garden rue, which may readily be seen by the unassisted eye.*

If the stamens or pistils are obliterated by cultivation, as in the case of double flowers, when the stamens degenerate into petals, the process of fertilisation is checked or destroyed; and a similar effect is produced by a long continuance of frost or other unseasonable weather. There are, however, a variety of very curious contrivances to protect the organs of fructification from suffering

* We are, as yet, but little acquainted with the internal structure of the pollen of plants, but a common microscope will serve to exhibit a very curious phenomenon in the sycamore-tree, which is no doubt common to many others. The flowers of this tree are suspended in long bunches, and usually blow about the end of April, when, if their pollen be viewed through a magnifying glass, each particle will be seen of a globular shape; but, if it be slightly moistened, the globules instantly burst open, and four valves are distinctly seen to expand.

injury. Sometimes this is effected by a nodding or pendent flower, of which the open portion is directed downwards till the seed has been duly fertilised. At other times the same object is answered by a periodical closing of the flower, so that its open and expanded corolla is directed to the sun's rays during the day, and yet the organs of fructification are effectually screened during the less genial temperature of the night. Any flower-garden will furnish us with a variety of examples of this phenomenon ; but one of the most beautiful is that presented by the white water-lily,* which, closing its petals as the sun begins to sink, and shrinking into itself, reposes its blossom upon the surface of the water till the morning, when it again rears its head, and presents its beautifully expanded corolla to the solar beams.

We have hitherto considered each flower as complete in itself, this is not, however, invariably the case ; and the fact of certain blossoms being sterile was well known at a very early period ; indeed, the ancients were practically acquainted with the fact, though ignorant of its true theory. Thus, in planting the date-palm, the early horticulturists brought the barren and fertile blossoms

* *Nymphæa alba.*

in the neighbourhood of each other. But, in the case of the fig-tree, mere vicinity is not sufficient, the structure of the fruit being such as to require a peculiar mode of transmitting the pollen. This will be better understood when we bear in mind, that the fruit of the fig is not, as in most instances, a case enveloping the seed, but a common calyx or receptacle, containing a vast number of florets. This may readily be seen in a longitudinal section of the fruit when fresh taken from the tree, and the interior will be found lined with the blossoms resembling a fungous mass; the only opening being at the larger extremity. Now it must be obvious, that the male and female blossoms which are generally in different figs, could not produce their proper fertilising effects without calling in some foreign agency. In this case the messenger of vitality appears in the form of a small insect; and any person who has seen the common bee passing from flower to flower, and covered with pollen, will readily understand how that important agent in the process of fructification is distributed. The insect in the case of the fig is principally employed in depositing her minute eggs in the fruit; and she thus comes in repeated contact with the loaded

anthers of one flower, the light covering of which she takes to another, and thus fertilisation is rapidly and effectively accomplished. It should, however, be borne in mind, that the access of the pollen is not usually trusted to accidental circumstances, as the stamens and pistils are generally found, like the members of one family, under the same roof.

When the sexual system was first promulgated by Linnæus, many objections were urged against it, and many different arguments were advanced to prove its fallacy. Among other specious reasons then adduced against the doctrine was the natural history of the *Valisneria spiralis.* This plant grows in the mud at the bottom of rivers in Italy and elsewhere, and produces male and female flowers separate from each other, and yet ripens seeds in due season. The plant being generally submersed, the opposers of the sexual system conceived it to be utterly impossible that, in such a dense medium as water, any transference of the pollen could, without destruction to its powers, take place.

But how triumphantly was this argument overthrown when the real history of the plant became known. The botanist attending to the habits and economy of this remarkable produc-

tion, found that the male flowers were seated on short, articulated, footstalks, and the females fixed to long spiral peduncles or footstalks, by which the flower was elevated to the surface at the proper season, whatever the depth of the water might be. He moreover discovered, that, when the male flowers were nearly perfect, they were deciduous, that is, detached from their stations, rose up, and floated about on the surface of the stream, the sport of winds and waves. About the same time the female flowers raised themselves by uncoiling their spiral stems, and gained the surface also. There they became fully expanded by the action of air and the light and heat of the sun; and there also they became obstructions in the way of their floating and vagrant mates, detaining them as they floated along, so that the necessary union thus took place. This accomplished, the female flower closes, and, shrinking from the air, retires again to the bottom to mature the seed.*

These wonderful circumstances were not only a refutation of this peculiar objection, which had

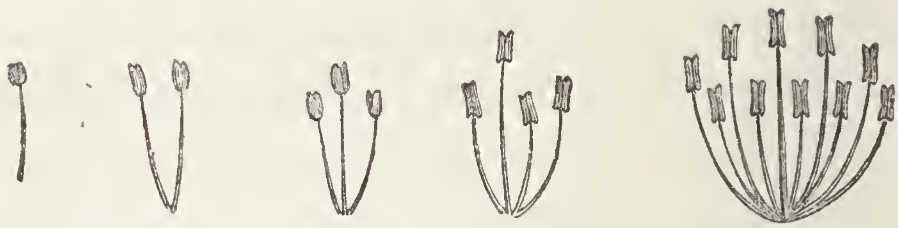
* The author is indebted to his friend Mr. Main, the ingenious illustrator of Vegetable Physiology, for a knowledge of the above interesting phenomena.

been urged with great force, against the universal application of the sexuality of plants, but they are also incidents for the admiration of the general naturalist, who sees in them the strongest proof of creative wisdom and almighty design. Nor have these facts escaped the imaginative visions of the poet: hence the beautiful lines of Darwin —

> " As dash the waves on India's breezy strand,
> Her flush'd cheek press'd upon her lily hand,
> *Valisner* sits, upturns her tearful eyes,
> Calls her lost lover, and upbraids the skies."

We must now, however, proceed to examine somewhat in detail the technical part of Linnæus's system. This distinguished naturalist divided all the plants then catalogued into classes, orders, genera, and species. The first of these divisions, forming the *classes*, is founded on the number, situation, or proportions of the stamens, whilst the *orders* depend in a great measure on the number of the pistils; and, to these simple combinations of the parts of fructification, we had better, in the first instance, direct our attention.*

* To render the classification more intelligible to the general reader, we prefix a tabular view of the classes and orders, which may advantageously be committed to memory by the botanical student.



[Stamens illustrative of the classes.]

The first eleven classes depend entirely on the number of the stamens, which, it will be borne in mind, are thread-like filaments placed within the corolla; and the primary one, *monandria,* is of

Classes.	*Number and Names of the Orders.*
1. Monandria.	2. Monogynia, Digynia.
2. Diandria.	3. Monogynia, Digynia, Trigynia.
3. Triandria.	3. Monogynia, Digynia, Trigynia.
4. Tetrandria.	3. Monogynia, Digynia, Tetragynia.
5. Pentandria.	6. Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Polygynia.
6. Hexandria.	4. Monogynia, Digynia, Trigynia, Polygynia.
7. Heptandria.	4. Monogynia, Digynia, Tetragynia, Heptagynia.
8. Octandria.	4. Monogynia, Digynia, Trigynia, Tetragynia.
9. Enneandria.	3. Monogynia, Trigynia, Hexagynia.
10. Decandria.	5. Monogynia, Digynia, Trigynia, Pentagynia, Decagynia.
11. Dodecandria.	6. Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Dodecagynia.
12. Icosandria.	3. Monogynia, Di-pentagynia, Polygynia.
13. Polyandria.	5. Monogynia, Digynia, Trigynia, Pentagynia, Polygynia.
14. Didynamia.	2. Gymnospermia, Angiospermia.

Greek derivation, expressive of its having but one stamen, or leading part of fructification. It contains two orders, *monogynia* and *digynia.* The first of these subdivisions possesses but one pistil, and may be illustrated with reference to the ginger and turmeric plants. Digynia embraces those flowers with two pistils, of which the common tickseed* is an example.

Classes.	*Number and Names of the Orders.*
15. Tetradynamia.	2. Siliculosa, Siliquosa.
16. Monadelphia.	7. Triandria, Pentandria, Heptandria, Octandria, Decandria, Dodecandria, Polyandria.
17. Diadelphia.	4. Pentandria, Hexandria, Octandria, Decandria.
18. Polyadelphia.	2. Decandria, Polyandria.
19. Syngenesia.	5. Polygamia æqualis, Polygamia superflua, Polygamia frustranea, Polygamia necessaria, Polygamia segregata.
20. Gynandria.	3. Monandria, Diandria, Hexandria.
21. Monœcia.	8. Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Polyandria, Monadelphia.
22. Diœcia.	13. Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Octandria, Enneandria, Decandria, Dodecandria, Icosandria, Polyandria, Monadelphia.
23. Polygamia.	2. Monœcia, Diœcia.
24. Cryptogamia.	9. Filices, Equisetaceæ, Lycopodineæ, Marsileaceæ, Musci, Hepaticæ, Algæ, Lichenes, Fungi.

* *Corispermum.*

The class *diandria* comes next in succession. It consists of such plants as bear flowers with two stamens. It is divided into three orders: monogynia, with but one pistil; digynia, with two; and trigynia, with three pistils. In the class diandria are found the lilac, privet, jasmine, the vernal grass, the pepper plant, &c.

Triandria, forming the third class, includes those flowers which bear three stamens. Like the preceding, it contains three orders, monogynia, digynia, and trigynia, which, we need hardly repeat, are dependent on the number of pistils in each flower. Here we find the crocus, that beautiful harbinger of the early spring, as well as numerous grass-like plants; but, above all, wheat, barley, and those other grains from which we mainly draw the necessaries of life.

Tetrandria, which forms the fourth class, possesses four stamens, all of an equal length. It is divided into three orders: monogynia, digynia, and tetragynia. These contain some very beautiful flowers, amongst which we may especially enumerate the banksia, lambertia, &c.

The class *pentandria* has five stamens, and contains six orders. They are thus named: monogynia, digynia, trigynia, tetragynia, pentagynia,

and polygynia. Monogynia is one of the most extensive orders in the Linnæan system, and contains some very extraordinary plants; amongst which we may enumerate those possessing powerful narcotic qualities, such as the hyoscyamus and the tobacco plant.* But its great ornament for modest and simple beauty, is the primrose, whose approach is thus heralded by our great epic poet:

> "Day's harbinger
> Comes dancing from the east, and leads with her
> The flow'ry May; who from her greenlap throws
> The yellow cowslip, and the pale primrose."

Digynia contains such plants as produce flowers with two petals, and, like the preceding order, has some very deadly poisons in its ranks. It is well illustrated by the umbelliferous plants.

Trigynia, as its name implies, has three pistils, and also contains several poisonous plants. But they are amply redeemed by the beautiful laurestinus, which blooms through the winter. Tetragynia has four pistils, and contains two families of plants; the grass of Parnassus, and the evolvulus.

Pentagynia has five pistils, of which the common flax will serve as an example: and, lastly,

* *Nicotiana.*

polygynia occurs, in which are placed those plants which have flowers with many pistils.

Hexandria forms the sixth class, and contains the orders monogynia, digynia, trigynia, and polygynia. The plants of this class have flowers with six stamens, which are nearly all of one uniform length.

The orders are all founded on the number of pistils, and we find the lily, the tulip, and the snowdrop the most interesting in monogynia. The other orders in this class are neither abundant in genera, nor yet beautiful in their character.

Heptandria, the seventh class, embraces those flowers which have a similar number of stamens. It is divided into four orders, monogynia, digynia, tetragynia, and heptagynia, all dependent on the number of pistils in each flower. This class contains but few plants of general interest; but the horse-chestnut will be found in monogynia, and is a tree which, from its common occurrence, furnishes frequent opportunity for illustrating this order.

Plants which produce flowers with eight stamens belong to *octandria*, the eighth class. It is subdivided into four orders, which are named from the number of their pistils, monogynia,

digynia, trigynia, and tetragynia. Under the first of these orders we may place the beautiful but common garden-nasturtium. Linnæus compared the flower of this plant to a helmet, and the leaf to a shield; so that the whole, according to his nomenclature, became the *tropæolum,* or trophy plant. But the great classifier of the vegetable kingdom might have called it a "natural electrical machine;" for such it really is, and well worthy the attentive study of every admirer of experimental science. In warm and dry weather, towards the close of the day, sparks of electric light may be frequently seen passing from one part of the plant to another; and these bright but evanescent corruscations are no doubt produced by a disturbance in the electric equilibrium, and caused by the growth of the plant. The following lines describe this singular electrical phenomenon with tolerable accuracy:

> "The chaste tropæolum quits her secret bed,
> A saint-like glory glittering round her head;
> O'er her fair form the electric lustre plays,
> And cold she moves amid the lambent blaze."

It may be proper to add, that the leaf of this plant is *peltate;* that is, the stem is fixed in the

disc of the leaf instead of the margin, and the upper surface is of an exceedingly beautiful green colour.

The willow-herb* and fuchsia are also striking illustrations of the order monogynia; and the rich pendent scarlet blossoms of the latter plant shew the exact arrangement of the stamens and pistil.

Enneandria, the ninth class, is named from the number of stamens which the blossoms exhibit. It contains three orders,—monogynia, trigynia, and hexagynia. We may especially notice the laurel, which belongs to the first of these orders, and, of course, bears flowers with but one pistil. This plant is indeed a native of classic ground, and its history is closely interwoven with our earliest studies. The laurel is usually considered as sacred to the deity of song, whose brows it is employed to bind.†

* *Epilobium.*

† This favourite tree of Apollo's gave name to a city of great importance in ancient times. This circumstance is thus recorded by Virgil:—

"Deep in the palace, of long growth, there stood
A laurel's trunk, a venerable wood,
Where rites divine were paid; whose holy hair
Was cut and trimmed with superstitious care.

The cinnamon and camphor trees, so well known for their powerful aromatic perfume and medicinal properties, also belong to the genus laurus.

The class *decandria* contains those plants which bear flowers with ten stamens. It contains five orders; monogynia, digynia, trigynia, pentagynia, and decagynia. In the first order of this class occurs that very singular plant the *dionæa*, or Venus's fly-trap, which furnishes a curious illustration of vegetable irritability. It has acquired its name from its power of catching insects. Each leaf of the dionæa is composed of three parts. It consists of a lower principal leaf, with two leaflets at the end. They are articulated close together upon a gland-like body, and the articulations act like hinges, permitting the leaflets to close when the gland is pressed by any foreign body. Now let us suppose a fly to approach, which it most probably does in search of the saccharine secretion: the instant he touches the gland the leaflets close, and he is effectually

This plant Latinus, when his town he walled,
Then found, and from the tree Laurentium called:
And last, in honour of his new abode,
He vow'd the laurel to the laurel's god."

shut in by a series of bristles, or spines, with which the edges of the leaflets are studded. Linnæus says, that when the insect ceases to struggle and becomes quiet, the leaf opens and the little prisoner may then escape: this does not, however, agree with Ellis's account, as he affirms that the trap does not again re-open; and many naturalists view the whole mechanism of the *muscipula*, or fly-trap, as a means of obtaining animal food for the plant.

In the order digynia we find the pink or carnation tribe,* so commonly employed to ornament our metropolitan gardens; and there are few flowers which have had a greater pecuniary value attached to them than the carnation. The hydrangea and saxifrage also belong to this order; and the curious granulated root of the latter plant has already been adverted to.

Hitherto the classes have been numbered in uniformity with the number of stamens, but in the eleventh class, *dodecandria*, are included all plants which produce flowers with from twelve to nineteen stamens. It is divided into six orders, which may be thus enumerated:—monogynia, digynia, trigynia, tetragynia, pentagynia, dode-

* *Dianthus.*

cagynia. These are all founded on the number of the pistils. This class is neither extensive nor interesting.

Icosandria forms the twelfth class, and embraces those plants which have twenty or more stamens inserted into the calyx or corolla. It is divided into three orders; monogynia, di-pentagynia, and polygynia. The first order contains one pistil, the next from two to five pistils, and the last an indefinite number. This class furnishes some of the most valuable of the fruit-trees, as well as the handsomest shrubs which adorn our flower gardens, and

> "The spiry myrtle with unwithering leaf,
> Shines here and flourishes."

Indeed, the myrtle forms a leading feature in the order monogynia, and is well deserving our attention, not only for the gratefulness of its perfume, but on account of its early notice in botanical history. Pliny, after enumerating many of the virtues of this tree, says, that it was the first planted in Rome. The ancients made great use of this plant in medicine, and they formed a kind of wine from the berries, with which they also flavoured the juice of the grape. It is a native of

Asia, Africa, and the southern parts of Europe. There appears some doubt as to the period when the myrtle was first introduced into this island. In Dr. Turner's history of plants, which was published in 1568, no mention is made of it. But we find Spenser in his "Faerie Queene" thus adverting to the "tree of love,"

> "Beside the same a dainty place there lay,
> Planted with myrtle trees and laurells greene,
> In which the birds sang many a lovely lay."

Indeed, it is most probable that this plant was introduced from Spain by Sir Walter Raleigh, about 1585, as he was travelling in that country a short time previously.

In the order polygynia we have the family of roses, the raspberry, dewberry, strawberry, and many other interesting plants.

LECTURE V.

LINNÆAN SYSTEM, AND NATURAL CLASSIFICATION, CONTINUED.

We must now direct our attention to the thirteenth class in the Linnæan system. It derives its name *polyandria* from its including those plants whose flowers have an indefinite number of stamens. They are usually reckoned in this class from twenty upwards, and all inserted into the receptacle. It contains five orders: monogynia, digynia, trigynia, pentagynia, polygynia. In the first of these orders we find the beautiful water-lily, which has not unappropriately been termed the Naiad of the streams.* The various species of this plant are beautiful aquatics; and we may particularly notice the water-lily which raises itself out of the water and opens its petals at an early hour in the morning, and again retires to its repose with closed petals about four in the afternoon. The Egyptian water-lily grows in vast

* *Nymphæa.*

quantities near Cairo during the inundation of the Nile. It flowers there about the middle of September, and ripens its seed towards the close of the following month. This is a very beautiful plant, and the ancients employed its flowers to decorate their temples, whilst its seeds were converted into bread.

The caper-tree also belongs to the same order, and produces the well-known pickle of that name. Both the flower-buds and the fruit are used for this purpose.*

Many of the plants in this class are particularly celebrated for their poisonous and acrid properties. We can only notice the crow-foot and hellebore,† both of which belong to polyandria polygynia. The celery-leaved ranunculus is one of the most virulent of our native plants. When bruised and applied to the skin, it speedily pro-

* In the islands of the Mediterranean the flower-buds of the caper are gathered just before they begin to expand, and are at once thrown into a cask with vinegar and salt, from which they are afterwards transferred to bottles for domestic use. We advert to this process to recommend care in the purchase of the caper, as the old and imperfect buds usually have a green tinge imparted to them by the agency of acetate of copper, which is a deadly poison.

† *Ranunculus* and *helleborus*.

duces a blister; and if taken into the stomach it produces the most dangerous effects.

The poisonous qualities of the hellebore are too well known to need a particular description; and it may be enough in the present place to remark, that those noxious properties, when properly directed by the hand of science, become a valuable remedy in the healing art.

Didynamia forms the fourteenth class, and, like tetrandria, the flowers have four stamens: but in tetrandria these are all equal; while in the present class there are always two long and two short to make up the amount. It contains two orders: gymnospermia, and angiospermia. The first of these contains the bitter-flavoured hyssop, and the highly fragrant lavender. We also find the mint, dead nettle, betony, horehound, marjoram, thyme, &c. in this class. The order gymnospermia, generally speaking, contains those didynamious plants which are destitute of a proper seed-vessel; whilst in angiospermia the seeds are covered.

Tetradynamia, forming the fifteenth class, is characterised by the plants having perfect flowers with six stamens, four of which are longer than the other two; and it thus differs from the plants

of the sixth class, in which the stamens are all of equal length. The flowers of this class are cross-shaped, and many of the plants are exceedingly valuable for their antiscorbutic properties. This class was divided by Linnæus into two orders, dependent on the form of the seed-vessel; the first called siliculosa, and the second siliquosa.* In this class we find the wall-flower† and common stock,‡ which form such great ornaments in most flower-gardens.

Monadelphia forms the sixteenth class. It is distinctly characterised by the filaments being united together throughout the whole or a part of their length; and contains seven orders, which are thus arranged: triandria, pentandria, heptandria, octandria, decandria, dodecandria, and polyandria.

The tamarind-tree, which belongs to the order triandria, may first be noticed. It is a native of the East and West Indies, as well as of Arabia

* This arrangement of a long and short pod having been found to interfere with a distribution of the genera according to their natural affinities, M. Decandolle has substituted an arrangement dependent on the relative position of the various parts of the seed.

† *Cheiranthus.* ‡ *Mathiola.*

and Egypt. The fruit consists of a long pod containing three or four seeds. In this country they rarely flower; but in their native climes there are few more beautiful objects.

The order pentandria contains the passion-flower,* which has been supposed to represent, in the appendages of its flower, the passion of the Saviour. The quadrangular-stemmed passion-flower is exceedingly beautiful in its tints. The petals vary from a bluish white to red, and the fruit is of an oblong shape, about six inches in diameter. When ripe it is of a greenish-yellow colour, and the rind contains a succulent pulp.

The order heptandria is formed of a single genus called the stork's-bill;† they are characterised by their irregular flowers and tubular nectary. The pelargonium tribe, or geraniums, as they are commonly called, have long become objects of general cultivation; and where light, air, and a moderate temperature can be obtained, there are few plants that more amply repay the possessor.

Diadelphia forms the seventeenth class, and the stamens are united into two separate parcels. It contains four orders: pentandria, hexandria, octandria, and decandria, all established on the

* *Passiflora.* † *Pelargonium.*

number of the stamens. Decandria may be considered as the most extensive and interesting order of this class. Here we find the common acacia;* and we have no tree that displays more elegant foliage than is formed by its beautifully pinnated leaves, which appear so judiciously scattered over the branches that not one obscures its fellow. The landscape-gardener usually arranges the clumps of these trees so that

> "Light-leaved acacias, and the shady plain,
> And spreading cedar, grace the woodland reign."

In *polyadelphia,* which forms the eighteenth class, the flowers have their stamens united into more than two parcels by their filaments. The orders of this class are but imperfectly defined. Sir James Edward Smith makes three divisions, and Lindley but two; but it contains many plants of great interest. Thus, the tree which produces the chocolate-nut† is found in decandria, and polyandria is graced by the orange-tree.‡

Syngenesia forms the nineteenth class, and comprehends, for the most part, those plants which produce compound flowers. With these the anthers are united into a cylinder, or tube. It is

* *Robinia Pseudacacia.* † *Theobroma.* ‡ *Citrus.*

divided into five orders : polygamia æqualis, polygamia superflua, polygamia frustranea, polygamia necessaria, and polygamia segregata ; all of which are founded on the disposition and character of the florets.

In polygamia æqualis, the florets, or partial flowers, are all perfect or united, an example of which occurs in the dandelion ; and in the polygamia superflua, the same character is preserved in the central florets, but those in the margin are furnished with pistils only. The latter of these orders may be best illustrated by a reference to the daisy, whose blossoms so sweetly enamel our own verdant meads.

" There is a flower, a little flower,
With silver crest and golden eye,
That welcomes every changing hour,
And weathers every sky.

'Tis Flora's page : in every place,
In every season, fresh and fair
It opens with perennial grace,
And blossoms every where.

On waste and woodland, rock and plain,
Its humble buds unheeded rise ;
The rose has but a summer reign,
The daisy never dies."

"The golden eye," to which the poet so beautifully alludes in the above passage, is in reality a multitude of small flowers or florets, each capable of carrying on the process of fructification, if, at least, we except a few that serve to encircle the central disk.

Gynandria, or the twentieth class, contains those plants furnished with perfect flowers, the stamens of which are inserted either upon the style or germen of the pistil. The number of orders in this class are made to vary considerably by different authors; but the best arrangement appears to be that adopted by Lindley, in which we have three divisions: monandria, diandria, and hexandria; the first having one stamen, the second two, and the third six stamens.

Monandria contains the orchis, which is a very beautiful genus of plants, possessing, amongst other curious properties, the remarkable one of gradually changing its locality in the soil where it is originally placed. This is effected by its root being formed by two tubers or bulbs, one of which is employed in the support of the plant, whilst the other is fitting itself for the same office in the following year, at which period the one previously

employed dies, so that, in the course of a few years, its situation is entirely changed.

Monœcia forms the twenty-first class, and the plants are particularly distinguished by their producing some flowers with stamens only, and others with pistils only, both growing on the same plant. It contains eight orders, generally dependent on the number of the stamens. They are thus arranged: monandria, diandria, triandria, tetrandria, pentandria, hexandria, polyandria, and monadelphia. The last order has the stamens united into a single body.

In the order monandria we find the tree which produces the bread-fruit,* which is one of the great wonders of the vegetable kingdom. It is a native of the Moluccas and the South Sea Islands, and frequently attains a height of thirty or forty feet. It abounds in a milky, viscid juice, and its leaves are two or three feet long, and often a foot and a half broad. Its fruit, which is fleshy, is as large as a full-sized melon, and is often employed as a substitute for bread. The properties of this tree are thus summed up by Dr. Hooker. The fruit serves for food; clothes are made from the fibres of the inner bark; the wood is used for

* *Artocarpus incisa.*

building houses, and making boats; the leaves for table-cloths, and for wrapping provisions in; and the viscid, milky juice affords bird-lime.*

In the order tetrandria we find the alder, a very valuable aquatic tree; which, like most other trees that are found in moist situations, inhales and corrects the deleterious properties of a damp atmosphere more rapidly than those which belong to a drier soil. According to Virgil this tree must

* The earliest account of the bread-fruit tree is furnished by Captain Dampier, in 1688. "The bread-fruit," says this navigator, "grows on a large tree, as big and high as our largest apple-trees; it hath a spreading head, full of branches and dark leaves. The fruit grows on the boughs like apples; it is as large as a penny loaf when wheat is at five shillings the bushel; it is of a round shape, and hath a thick, tough rind. When the fruit is ripe it is yellow and soft, and the taste is sweet and pleasant. The natives of Guam use it for bread. They gather it when full-grown, while it is green and hard; then they bake it in an oven, which scorcheth the rind and maketh it black; but they scrape off the outside black crust, and there remains a tender thin crust, and the inside is soft, tender, and white, like the crumb of a penny loaf. There is *neither seed nor stone* in the inside, but all of pure substance, like bread. It must be eaten new, for if it be kept above twenty-four hours it grows harsh and choky; but it is very pleasant before it is too stale. This fruit lasts in season *eight months* in the year, during which the natives eat no other sort of bread.

have formerly grown to a much greater size than we now find it, as he, speaking of the early navies, refers to the period when

> " First on seas the hollow'd alder swam."

It is no small recommendation to these trees that their branches do not injure the growth of grass or under-shrubs in their neighbourhood, a property which they in a great measure derive from their revivying effects on the atmosphere.

The order polyandria produces, amongst other interesting plants, the begonia, so celebrated for the beauty of their flowers and foliage. Here also we find the oak ;* and it is a curious circumstance that this class contains nearly all the trees employed in the infancy and manhood of the naval art. The alder formed the earliest bark of the Romans; the oak, that masterpiece of human ingenuity, a British ship of war.

The order monadelphia produces the pine; and this, like the preceding, is well fitted for naval purposes, though but little employed.

> " The tough yew repels invading foes,
> And the tall pine for future navies grows."

* *Quercus.*

In addition to its value for the spars of ships, it produces a valuable resinous matter, which forms an essential article in domestic as well as naval architecture.

The twenty-second class, *Diœcia*, contains those plants which have no perfect flowers, but produce flowers with stamens on one plant, and flowers with pistils on another. It is usually divided into fourteen orders; but some of the best botanists admit but thirteen. They may be thus enumerated: monandria, diandria, triandria, tetrandria, pentandria, hexandria, octandria, enneandria, decandria, dodecandria, icosandria, polyandria, and monadelphia.

The willow* belongs to the order diandria, and it is a highly interesting tree, not only for its early associations, but for its light and beautiful foliage. The weeping willow† is frequently adverted to in Holy Writ; and the highly poetical lamentation of the captive children of Israel, when they sat down "by the rivers of Babylon," and hanged their "harps upon the willows," is unequalled for beauty and pathos. This species of willow grows spontaneously in China; and one

* *Salix.* † *Salix Babylonica.*

of the earliest introduced into this country was planted by Pope at Twickenham.

In the order pentandria the flowers of the barren plant have five stamens; and amongst other beautiful plants, contains the pistachia-tree and hop. The first of these is very common in the East, where it is cultivated for its nuts. The "lamb fed with pistachia-nuts," it will be remembered, formed part of the imaginary feast provided by the Barmecide, in those delightful fictions, the Arabian Tales. The flowers containing the stamens proceed from the branches in loose bunches, and the female flowers in open clusters; and as the flowers containing the stamens ripen first, it is common for the gardeners to gather those flowers, and when the others appear sprinkle them with the dry pollen. The hop belongs to the same order, and there are few more interesting sights than this plant furnishes, when its highly scented flower, and rich foliage, has attained its maturity. Indeed, the much-boasted vintage exhibited in the south of France offers nothing to compare, in point of picturesque beauty, with a Kentish hop-garden in the month of September, when the picking of the flowers is about to commence.

The order octandria contains the poplar, so well known in this country as the tree "that with silver lines its leaf." The ancients, who had a fable for every subject for which they could not find a philosophical reason, thus accounted for the different hues which the leaf has on its opposite sides. The poplar was sacred to Hercules, who wore it on his descent to the infernal regions, and the leaves of which the hero's crown was composed are said to have been acted upon by the flames on the side exposed to their action, whilst the under side retained their silvery hue, being protected by the brows they were employed to bind. The aspen poplar,* with its slender leaf-stalks, forms a pleasing variety in ornamental pleasure-grounds.

The twenty-third class, *polygamia*, contains such plants as produce three different kinds of flowers. They may be thus briefly characterised: some are furnished with pistils only, some with stamens only, and others with both; and these flowers may be situated either on the same individual plant, or on different plants of the same species.

It is divided into two orders, monœcia and

* *Populus tremula.*

diœcia. The first of these contains the sensitive plant,* which exhibits phenomena nearly allied to the nervous irritability in animal life; and, though much attention has been given to the subject by Dutrochet, its real theory still remains unexplained. The maple also belongs to this order, and it was formerly considered as a royal tree. Thus we find Virgil celebrating it as the throne of Evander, on which he received and seated Æneas.

The common maple† flowers in the beginning of April, and the leaves usually appear a few days later. The sugar maple‡ is of great importance to the inhabitants of North America, as its saccharine sap affords them sugar but little inferior to that procured from the cane in the West Indies.

The order diœcia contains, amongst other valuable plants, the ash and fig trees, the latter of which furnishes so important an article of food both in the East and some parts of Europe.

The class *cryptogamia* is the twenty-fourth in the series. It contains a vast assemblage of vegetables, in which the parts of fructification are, either from their minuteness, or from their

* *Mimosa sensitiva.* † *Acer campestre.*
‡ *Acer saccharinum.*

particular situation, entirely concealed or imperfectly understood. This class has been differently divided by different authors; and from the time of Linnæus there are hardly two writers on systematic botany who have exactly pursued the same order of arrangement.

The cryptogamic plants are very numerous, so much so, indeed, as to forbid any detailed view of their classification. We must, therefore, in the present place, confine ourselves to a view of their more strongly marked characteristics, which will thus enable us to give a notion of their general arrangement. We may commence with *filices*, or the ferns, in which the reproductive organs are inserted on the back surfaces of the leaves or fronds. The common brake, or fern, a well-known plant in most of the heathy districts of this country, will sufficiently illustrate its character.

The *mosses* come next in order. They are distinguished by the peculiar nature of their reproductive organs, which consist of a sort of cup-shaped vessel furnished with a lid, and containing a number of sporules, or cryptogamic seeds. They have, however, another arrangement, which consists of a series of minute spherical

pedicellated organs, concealed in the axils of some of the leaves, and somewhat resembling anthers. The mosses are, generally speaking, too well known by their external characteristics to need any separate illustration.

The order *hepaticæ,* or liverworts, is composed of a tribe of small plants, resembling mosses; in which the herbage, generally speaking, is leafy, but the small cups or capsules which contain the seed are destitute of a lid.

The order *algæ* is mainly constituted of the sea-weeds of the ocean, and of the floating, scum-like substances found in ditches and rivers. The sporules are naked, or immersed in the frond or leaf of the plant.

In the *lichens* the sporules are deposited in receptacles distinct from the frond, whilst the *fungi* have the sporules arranged in tubular cells. The mushroom occupies an important place in the list of fungi; and it is a source of regret that it is not more generally cultivated as an article of domestic economy.

We have thus taken a brief view of a class of plants which may not unaptly be characterised as the lowest in the scale of vegetable life; and yet even here the Creator of all things has not left

himself without sufficient evidence of his care in supplying the wants of man. The moss and the lichen in many parts of the world form the main support of the animal kingdom. This applies, in an especial degree, to the rein-deer, without which so large a portion of the frozen parts of our globe would be uninhabitable; as most of the cryptogamic plants will vegetate under any circumstances, and the utter absence of the ordinary accessories to vegetation is no bar to their rapid growth. The darkest cellar, and the most impure atmosphere, has its never-failing crops of cryptogamia, and even the charnel-house is adorned with pendant curtains of these plants.*

* From this brief account of the artificial system of Linnæus, it will be seen that the classes and orders constitute his primary divisions of the vegetable kingdom. In addition to these, however, he has a further division into genera, species, and varieties. Thus, in most of the orders the student will find some plants which have one or more peculiarities that agree with each other, as in the case of the roses, the hyacinths, or the heaths; and on these the genera are constructed. But, like the preceding divisions, they are also subject to a further division into species, and the latter again into varieties. These consist of plants possessing minor distinctions, partly resulting from soil, situation, or other local causes, by which the leaves and even the flowers are subject to a change of colour and character.

LECTURE VI.

LINNÆAN SYSTEM, AND NATURAL CLASSIFICATION, CONCLUDED.

In the previous lecture we completed a general view of the artificial arrangement of Linnæus, and may now briefly examine that system of classification which has a natural division of the vegetable kingdom for its basis. We pass by the fragments of a natural system furnished by Linnæus, as well as the incomplete attempts of others who had preceded him, and at once come to that proposed by Jussieu. This is mainly founded on a consideration of the cotyledons or seed-lobes, and he arranged all vegetables under three general heads, for which he proposed the terms *dicotyledones,* when the plant had two or more seed-lobes; *monocotyledones,* in those cases in which there was but one; and *acotyledones,* when the seed-lobes were not present, or indistinct. He

further divided them into classes, orders, and other minor divisions.*

There are also two very important divisions of the whole vegetable kingdom, which must be briefly adverted to at the outset of our sketch. These depend on very obvious characteristics in the structure of the plant. The first grand division is entitled *vasculares;* and the second, which comprehends a much more humble class in the scale of creation, is entitled *cellulares.*

The vascular, or cotyledonous plants, are again separated into the great classes dicotyledones and monocotyledones, both of which are distinguished as accurately by their physical structure as by the peculiarities of their seed, and incipient vegetation. The vascular plants are all formed with a beautiful mechanism of tubes and fibres, woven into a frame-work nearly allied to that of the human structure. They are composed

* These have been very materially changed, both in their number, titles, and character, by subsequent botanists; and the most comprehensive view that the author has seen in the English language, is that furnished in *Loudon's Encyclopædia of British Plants,* a work unequalled for the excellence of its arrangement and the accuracy of its execution.

of an expansive tissue, woody fibre, and a series of spiral vessels, whilst the leaves are traversed by distinctly formed veins, which will, however, be better understood when we come to treat of the foliage in the next lecture.

The dicotyledonous plants are subdivided into *dichlamydeæ*, and *monochlamydeæ*; and the first of these is further divided into thalamifloræ, calycifloræ, and corollifloræ, of each which we may now take an example.

The sub-class *Thalamifloræ* comprehends those plants in which the petals are inserted into the receptacles; and it opens with the order *Ranunculaceæ*. In this order, amongst other beautiful plants, we find the clematis, or virgin's bower. The sweet-scented clematis* is a very attractive plant, and appears to have been introduced into this country early in the sixteenth century. It is a native of the southern part of Europe, and is exceedingly abundant in France and Italy. In this country its clusters of small white flowers are too well known to need a particular description; and it serves to illustrate both the present natural division, and polyandria poly-

* *Clematis Flammula.*

gynia, the latter of which is its situation in the Linnæan system.

The carnation belongs to this division of dicotyledonous plants, and is placed in the order *Caryophylleæ*. The whole of the varieties of this plant are supposed to have sprung from the Dianthus caryophyllus, and there are now many hundreds of varieties. Some of our most beautiful carnations have originally been imported from Italy, in which country the plant is occasionally found growing in a state of wild nature.

In the order *Nymphæaceæ*, we find some interesting water-plants. Their large and beautifully tinted leaves sometimes float on the surface of the water, and at other times are supported by their powerful stems so as to waft the plant over a considerable extent of its native element. The common water-lily* has a large flower; but the Egyptian lotus, from its historical recollections, forms the primary feature of attraction in the order.

The sub-class *Calycifloreæ*, is characterised by the petals being separate and inserted into the calyx. The rose, which forms so distinguished

* *Nymphæa alba.*

a feature in the order *Rosaceæ*, will serve as a familiar illustration of these plants. Most of the sacred, as well as profane, authors abound in illustrations of the habits and beauty of the rose. Thus we find the "Rose of Sharon" often adverted to in Holy Writ; and the ancient eastern poet, Jami, beautifully describes its slender petals, when he says that "the nightingales warbled their enchanting notes, and rent the thin veils of the rose-bud and the rose."*

This plant is supposed to have given name to the Holy Land, as Syria is derived from *Suri*, a beautiful species of the rose, for which that country has always been celebrated; — and hence it is still called *Suristan*, or the "Land of Roses." The peculiar affection which the nightingale bears to this plant is well known, though it is best shewn in its own beautiful clime.

This interesting fact in natural history has been admirably portrayed both by the eastern

* Moore's description of this plant is too beautiful to be passed unnoticed. It occurs in his *Translations of Anacreon.*

> "Rose! thou art the sweetest flower
> That ever drank the ambient shower;
> Rose! thou art the fondest child
> Of dimpled Spring, the wood-nymph wild!"

and our own poets. Thus we find Jami declaring that " you may place a hundred handfuls of fragrant herbs and flowers before the nightingale, yet he wishes not, in his constant heart, for more than the sweet breath of his beloved rose." And Moore, our own exquisite modern lyrist, says :—

> " Oh ! sooner shall the rose of May
> Mistake her own sweet nightingale,
> And to some meaner minstrel's lay,
> Open her bosom's glowing vale."

In this country the rose finds a place in almost every garden ; and it might be advantageously employed to a still greater extent, for the manufacture of the costly perfume which its petals furnish. There are many of these plants that are natives of Great Britain, the most delightful of which is the sweet-briar, or eglantine.* The dog-rose † decorates our hedge-rows with its prettily-painted and fragrant flowers, during the months of June, July, and August ; and they, like the garden-rose, might be made a great source of profit, for the purposes of distillation. It may hardly be necessary to add that the fruit

* *Rosa rubiginosa.* † *Rosa canina.*

makes a fine conserve, well fitted, according to the good old botanist, Gerard, for the preparation of "most pleasant meates and banketting dishes." The rose occupies a place in the second order of the twelfth class in the Linnæan system.

The strawberry* belongs to the order *Rosaceæ*. This plant may not unaptly be termed the parent of health, as there are many instances on record of its having produced the most extraordinary effects, both in phthisis and other cases of bodily debility. There is one very peculiar property of the strawberry which should not be passed unnoticed, namely, that it rarely, if ever, produces acidity on the stomach; and it is altogether a very wholesome and delicious fruit. The delicate white blossoms prettily contrast with the deep green leaves, which it puts forth in great luxuriance; and it would, in most cases, form a very excellent substitute for the quaintly clipped box, which so frequently disfigures our garden-borders.

The pomegranate occurs in the order *Myrtaceæ*, and appears to have originally come from Carthage. Its fruit contains a luscious pulp, in which the seeds are buried, and which, when

* *Fragaria*.— Linnæan class and order Icosandria polygynia.

blended with water, forms a very refreshing beverage in its native climes.*

The jasmine also belongs to the dicotyledonous plants, and it will serve to illustrate the sub-class *Corolliflorœ,* to which belong all the genera of plants which have a monopetalous corolla, with the stamens inserted into it, and a superior ovarium. We hardly know which to admire most in this plant, its delicate perfume, or the simple beauty of its modest flowers. Cowper, who, however sombre he may be considered in his didactic poetry, certainly had a very accurate perception of the beauties of nature, prettily describes both flower and foliage :

> " The jasmine, throwing wide her elegant sweets,
> The deep dark green of whose unvarnished leaf
> Makes more conspicuous, and illumines more
> The bright profusion of her scatter'd stars."

The common white jasmine* appears to have come originally from the East, and it grows in great profusion about the coast of Malabar. From its slender tube is procured the sweetest honey ; and this plant is eagerly sought by the active

* The Punica belongs to Icosandria monogynia.

† *Jasminum officinale.*

inhabitant of the apiary. The Turks cultivate the jasmine to a great extent for the sake of the branches, which they employ in the construction of their light summer tobacco-pipes. In the Linnæan classification, it belongs to diandria monogynia.

In the order *Primulaceæ* occurs the auricula, —a plant which owes much to cultivation, but still more to its own natural beauty and simplicity. It is a native of the Alpine regions of Europe, and some parts of the East. In a highly cultivated state, its richly grouped flowers and delicately tinted leaf give it a high value with the florist.*

The second subdivision, *monochlamydeæ*, is characterised by the absence of a corolla. In the order *Chenopodeæ* we find some very important plants, and, amongst the rest, the gigantic beet, occasionally employed as a culinary root; but its real value is but little estimated in this country. In Germany, the *mangold wïrtzel*† forms a very important article of food. The leaf nearly resembles spinach, and the midrib is frequently

* The auricula belongs to the class and order pentandria monogynia.

† *Beta Cicla.*

removed and used as asparagus; but its vast root has not inappropriately procured for it the title of "root of scarcity." The plant when macerated produces a great quantity of sugar, and the refuse is well fitted for the support of cattle: indeed, the whole plant is exceedingly nutritive, and, amongst other virtues, forms when roasted a good substitute for coffee. In the Linnæan system, it occupies a place in pentandria digynia.

In the same subdivision, and in the order Urticeæ, occurs the fig, the hop, the bread fruit, the mulberry, and the upas, several of which have already been described. The upas is now known to be a very harmless plant; and the travellers' tales, which represent it as the plague spot of its native clime, are entirely without foundation.

The *monocotyledonous* plants are usually arranged under three heads, in which the stamens are either epigynous, perigynous, or hypogynous. In the first case the stamens are superior—that is, situated over the ovary, or style. The crocus belongs to the order *Irideæ*, and its stigmas form the well-known saffron—valuable not only for its medicinal, but also for its colouring, pro-

perties. Haworth found that the blue and purple kinds ripened their seeds much more readily than the yellow—a circumstance, no doubt, dependent on the effects of the sun's rays on those colours. When the plant is in flower, the germen is situated under ground, almost close to the bulb; but some weeks after the decay of the flower, it rises on a white foot stalk, and ripens its seed in the air. The crocus belongs to triandria monogynia.

In the order *Amaryllideæ* there are many beautiful plants, amongst which we may particularly place the unassuming snowdrop, which is seen in all its vernal beauty combating with the snows of winter, and almost rivalling them in the snowy whiteness of its blossoms. It belongs to hexandria monogynia.

In the second section, the stamens are *perigynous,* or attached to the orifice of the calyx. The palms form one of the distinguishing ornaments of the monocotyledonous plants. They are exceedingly long lived; and though their structure be simple, they grow to a great altitude in those climates which are fitted for their full developement. The palms are formed of successive circular crowns of leaves, which rise from the

bottom of the stem. When one circle has performed its office, another rises within it, which is seen a little above the preceding one. Thus successive circles grow one above the other, by which the vertical increase of the plant is carried on to an indefinite period. The leaves, prior to their complete expansion, are folded in small plaits from the base to the apex. The flowers are small, and contained in a bag called a spathe, generally evolving the most fragrant odours.

The fan-palm* is a very extraordinary plant, and, as its name implies, is furnished with a large fan, or rather a series of fans, from fifteen to twenty feet in length. In the island of Ceylon it is called the tallipot tree, and it is said by Knox to grow as tall as a ship's mast. The leaves are of great use, as a single one has been found large enough to cover a considerable company of persons; and the natives employ them as a species of temporary covering during rainy weather. The pith of the plant, when beaten in a mortar, and baked in the ordinary way, forms a very nourishing and agreeable article of food. The fruit of the tree is about the size of a large cherry; and the smaller leaves serve as a good substitute for

* *Corypha.*

paper; indeed, most of the old manuscripts in that part of the world are written on this material. In the Linnæan classification, the fan-palm is placed in hexandria monogynia, being provided with six stamens and one style.

The date-palm* is an exceedingly valuable tree, and its fruit forms the principal article of food in Arabia and many other parts of the East. The leaves of the tree are woven into bags and many articles of light and elegant furniture; whilst the footstalks are used in the erection of their houses and as fences for their fields; the fibrous threads of the plant make a very fine cordage; and, lastly, its juice forms an excellent beverage, of which a single date-tree will produce several pints a-day.†

In *Liliaceæ* occurs the well-known tulip, a plant which has excited more interest in a commercial point of view than any other which has fallen under our notice. Moderate fortunes have been given for a single root; and, though the mania may now be said to have passed away, rare plants still fetch large prices. The flower of the tulip is valuable to the young botanist as

* *Phœnix*.

† The date-palm belongs to diœcia tetrandria.

it shews the parts of fructification on a large scale; and its six distinctly formed stamens mark it to belong to the class hexandria. Another very beautiful illustration of this division may be adduced in the hyacinth. It belongs to the order *Asphodeleæ;* and is a valuable plant for illustrating the process of vegetable growth, as its bulb may be placed in a glass prepared for the purpose, and the long fibres beneath will be seen to increase in length with great rapidity. The tendency that roots generally have to proceed in a downward direction may also be shewn; and if any obstruction be offered to the progress of the fibres of the plant they will be seen to take a new direction, but little longer than the obstructing body remains in their path. The flowers of the hyacinth have very much the appearance of being moulded in wax; and the principal varieties are double, semi-double, single, red, white, purple, and blue.*

In the third section we find plants with the stamens *hypogynous*, that is, fixed into the same receptacle as the pistil. The order gramineæ forms the distinguishing feature of this division. It contains a variety of plants of the greatest im-

* The hyacinth belongs to hexandria monogynia.

portance to man, both as furnishing his every-day food, and also the most useful herbage for cattle. It may be taken as an axiom that those plants which are universally fitted for the support of animal life are well calculated to bear variations of climate; and it is a beautiful provision of nature which makes our most important harvests the produce of grasses rather than of forest-trees; for if the latter was the case, the elemental storms or the still fiercer ones which arise from the contentions of ambitious men, would produce years of want, and ultimately tend to depopulate the earth. But the blade of grass bows to the wind; and if the destroyer comes, the passage of a few short months restores every thing to its original vigour and usefulness. Wheat,* barley,† and rye,‡ all belong to triandria digynia in the Linnæan classification.

There is a very curious order of plants in this section which must not be passed unnoticed. The *Aroideæ*, generally speaking, have large fleshy leaves, and their flowers are enclosed within a spathe, being imbedded on a simple cylindrical spadix. The dragon-arum § will well illustrate

* *Triticum.*

† *Hordeum.*

‡ *Secale.*

§ *Arum dracunculus.*

this order. In the Linnæan system it belongs to the class and order monœcia polyandria. In a recent state the flowers have a powerful smell of putrid animal food, and so strong is the affluvia, that birds and insects which prey on carrion have been known to mistake it for their natural food.

We may now notice, though of necessity but briefly, the second great division of the vegetable kingdom, in which the plants are differently constructed from those we have been examining, and, in consequence of their peculiar organisation, are denominated *cellulares*, or acotyledonous plants. They are destitute of visible seed-leaves; or, in other terms, the plants which belong to this great division of the vegetable kingdom, produce such minute seeds that the cotyledons are not to be detected with any certainty, and as such, vegetable organisation exists in its most simple state. They are divided into two great classes, *foliaceæ** and *aphyllæ*.† The first of these contains four orders: the most prominent of which is the fern-tribe, justly considered as the most beautiful of all the orders of cryptogamic plants.

The second class contains five orders, amongst

* Foliaceous, or leafy. † Leafless.

which we may particularly enumerate the lichens and the fungi. We have already had occasion to speak of the first of these plants as of great importance in the support of animal life; and we might have added, that they are highly useful in the economy of nature, by preparing the way for the larger and apparently more important vegetables. They grow up, come to maturity, and perish on the same site; forming in the process of time a soil of considerable depth, till at last, in the revolutions of ages, the surface of the barren rock becomes coated with a rich and nutritious soil, capable not only of supporting a vernal covering, but sufficiently deep to imbed the roots of the loftiest trees.

In the list of *fungi* we find the mushroom, which in its flavour so nearly resembles some kinds of animal food; and we can hardly survey the little fairy rings formed by the champignon,* and supposed to have been produced by the kindly visits of the "good people," without regretting the loss of that simple and beautiful infantile mythology, so well adapted to the unmatured judgment of youth, and which peopled the world with good and intelligent beings, the watchful guard-

* *Agaricus pretensis.*

ians of innocence as well as the prompt punishers of evil.

The true mushroom * is beautifully distinguished by its polished columnar stem, and its pleasing odour, from the greater part of the poisonous fungi.

The various tribes of fungi may not inaptly be characterised as the lowest class of vegetable bodies. Here, however, we find some most extraordinary plants, and many of them amazingly rapid in their growth. They are wholly formed of cellular matter, and gain magnitude by a uniform swelling motion from the centre outwards. They vary very considerably in their size; for whilst the *boletus,* or tree fungus, is found in Java much larger than an umbrella, the smaller sorts compose the mimic forests of mould which are seen but to colour the surface of a small fragment of cheese, and whose structure can only be understood by employing a microscope of high magnifying power. But, simple and unimportant as the fungi may at first view appear, they form links in the chain of creation which serve to connect and harmonise together elements of the most discordant nature, all working together for the

* *Agaricus campestris.*

benefit of man, and forming imperishable monuments of the goodness of his Creator.*

* The study of botany would be very materially facilitated if the preservation of plants in a dried state was more generally attended to; and the necessity for this is peculiarly apparent in studying the classification of plants. One of the first steps taken by the student in mineralogy or geology is to procure specimens of the various natural bodies which come within the range of these respective sciences; and in the same way the botanist who would promise himself any progress in his highly attractive pursuit must go to nature, and he will find her treasure-house abundantly provided with all the materials that are required. For this purpose, we may go either to hill or dale, or search in the wildest sequestered valley, and we shall find each as prolific as the richest flower-garden. We may thus, in any season of the year, place the works of nature before us, and consult them with the greatest advantage. A few facts illustrative of the mechanical processes resorted to in preparing a really useful herbarium may now be offered. The collector should, in the first instance, be provided with a small tin case, or basket, in which the specimens should be placed as soon as gathered; and from thence transferred to clean blotting-paper. Fresh paper must occasionally be substituted till the plant is completely dry. Each specimen should then be slightly passed over with a camel-hair pencil dipped in a solution of corrosive sublimate of mercury in spirits of wine. This is a very important part of the process, as it effectually protects the plants from the attacks of insects who would otherwise destroy them.

After the plants are thus prepared, they should be arranged in a natural form in a large book, the title of each being placed

beneath. A little weak glue will preserve the specimens in their proper situations, and the occasional use of a narrow band of paper will give stability to the whole. The heaths and firs are best preserved by a previous immersion in boiling water; and the flowers should be carefully and rapidly dried to prevent the chemical decomposition which will otherwise injure the colours.

This process, simple as at first view it may appear, is not only advantageous to the practical botanist, but may be rendered exceedingly useful to the student; and the varied productions of every part of the globe may thus readily be procured in all seasons in a nearly natural state.

LECTURE VII.

THE LEAVES, FRUIT, AND VARIOUS SECRETIONS OF PLANTS.

Having in the previous lectures traced the structure of a plant with reference to its stem and parts of fructification, it may now be advisable to direct our attention to its leafy covering. The foliage of a plant, although in most cases but a temporary part of its structure, may be considered as one of its most valuable appendages. Generally speaking, the rising stem appears formed but to bestow a "wood of leaves;" and when spread forth they always act a most important part in the economy of vegetation.

The leaf is in most cases a thin flat mantle, or extended sheet, of a green colour, and generally springs from the extremity of the branches; but to this arrangement there are numerous exceptions. Thus, we find the leaves of many plants thick and succulent, of which the aloe and houseleek may be taken as examples; and the leaves

of many of the "ever-greens," as they are termed, are of every variety of hue. Other plants, again, instead of being of one clearly defined tint, are richly striped or spotted; but green is the prevailing colour, both in woodland and pasture scenery.

> "In various hues; but chiefly thee, gay green!
> Thou smiling nature's universal robe!
> United light and shade; where the sight dwells
> With growing strength, and ever new delight."

There is no single plant whose leaves offer so great a variety of tints as the Virginian creeper.* Its colours pass through all the entire range from green and yellow on to the most brilliant red. It thus has the effect of the most lively coloured blossoms, and when allowed to twine round other trees with a foliage of a fixed green colour, the effect is exceedingly pleasing.

The poplar, "that with silver lines its leaf," furnishes a curious example of the effects which result from contrast of colour in its own foliage, as the upper and under surfaces of the leaves differ materially in their tint; and a tree of this description, when agitated by the wind, strongly reminds us of the undulations of the ocean when

* *Ampelopsis hederaca.*

seen by moonlight. The varieties of colour, like those of form, are, however, too numerous to be examined in detail; and it may be enough to say, that they are boundless and ever-varying.*

In technically describing the leaf, the point by which it is attached to the plant, is considered as

* In the above sketch we have delineated some of the most marked and characteristic forms of leaves. In the first example the leaf is delicately veined and serrated. The general characteristics of this leaf are found in the garden-rose and sweetbriar. In the central figure, the leaf being fuller in the margin than in the centre, it lies in a series of delicate folds, and the landscape-gardener avails himself of this circumstance and happily contrasts this kind of winter foliage with leaves of a smoother character.

That arrangement of leaf which is technically called perfoliate, is, however, of a still more curious character: it is represented in the third figure. We have already adverted to the peltate, or shield-like form, assumed by the nasturtium; but in the present case the leaf possesses much of that figure, with the addition of the stem running through a point near the centre. An example occurs in the Uvularia.

the base; the terminating point opposite as the apex; the intermediate body of the leaf as the expansion, and the boundary of the expansion as the margin. The base is, however, in many cases but a point in which the expansion originates, and connecting it with the branch or stem. Those leaves which are furnished with a stem, or foot-stalk, are said to be petiolate, and this is the character of a large proportion of the plants which adorn the face of nature.

The figure of the footstalk is generally cylindrical, but it is frequently expanded at the base, so as to enable it to partially surround the stem, and then it is said to be winged. When it entirely invests the stem, as in the case of the grasses, the footstalk is denominated the sheath.

The plants of this country generally produce an abundant harvest of foliage; but in this respect we are far behind many other parts of the world. The luxuriance of vegetable life in South America has thus been adverted to by the distinguished naturalist, Baron Humboldt: he says that "when a traveller, newly arrived from Europe, penetrates for the first time into the forests of South America, if he is strongly susceptible of the beauty of picturesque scenery, he can scarcely define the

various emotions which crowd upon his mind; he can scarcely distinguish what most excites his admiration,—the deep silence of these solitudes, the individual beauty and contrast of forms, or that vigour and freshness of vegetable life which characterise the climate of the tropics. It might be said that the earth, overloaded with plants, does not allow them space fully to unfold their leaves. In the torrid zone, creeping plants often reach from the ground to the very summits of the trees, and pass from one to another at the height of more than a hundred feet, so as to deceive the observer, and lead him to confound the flowers, the fruit, and the leaves, which belong to different species."*

One of the prominent uses of leaves is to protect the plants on which they grow from the excessive action of the sun, and moisture. At first view it might appear, that the fruit would be

* The above passage gives us a very vivid notion of the extraordinary character of these interminable wilds which, under the most gorgeous garniture, conceal the seeds of miasma and death. The hand of the Creator has spread abroad both abundance and beauty, and the labours of man are only required to convert this luxurious wilderness into a land of plenty.

benefitted by their removal; such, however, is not the fact, as many shrubs when stripped of their leaves scarcely produce any fruit; and though others appear to be partially benefitted, yet, on the whole, the indiscriminate abstraction would rather produce injury than benefit. Light and air, which so essentially influence the vegetable kingdom, act chiefly on the leaves; and, in relation to the air, leaves have not unaptly been compared to the animal organs of respiration,—to lungs placed externally.

The respiration of plants beautifully illustrates the adaptation of animal and vegetable life for their mutual support in the economy of nature. It is well known that man, while carrying on the respiratory process, rapidly deprives the atmosphere of its oxygen, that is, the vital air which forms but a small part of the whole. After the air has passed through the lungs it again enters the atmosphere charged with a large quantity of carbonic gas, which latter body is incapable of supporting animal life; but the wisdom of Omniscience, by exactly fitting this deleterious gas to the wants of the vegetable kingdom, has converted it into a most useful adjunct in the economy of creation. The beauty and harmony of the process

does not, however, end here, as the carbonic gas which is thus taken up by the plant is returned into the atmosphere in the form of vital air. Thus we find that Nature, always the most perfect economist, and unerring in her calculations, has so ordained that the atmospheric air which has been injured by animal respiration shall be calculated to support vegetable life; and on the other hand, that the respiratory gases of plants shall be exactly adapted to supply the wants of the animal kingdom.

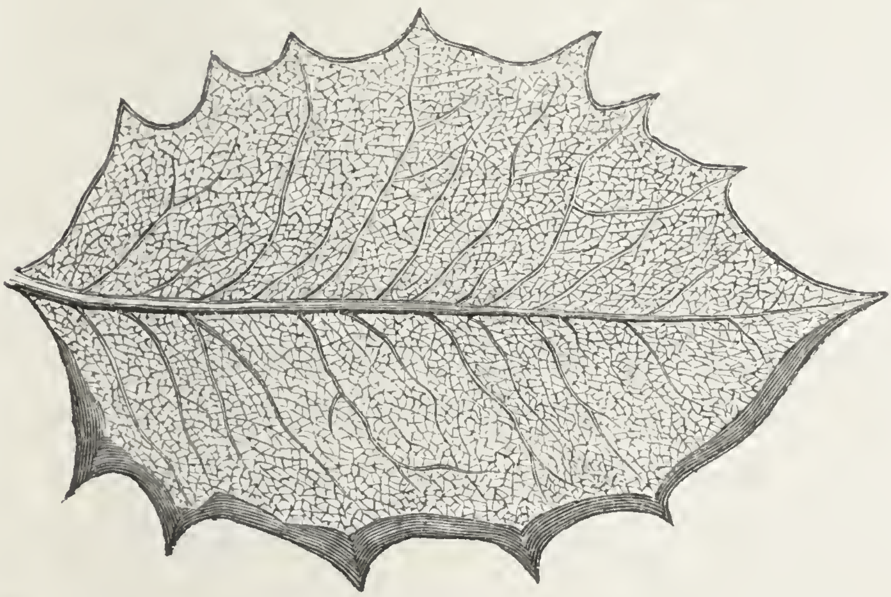
It appears that there is a very material difference between leaves that grow in water and those that grow in air. In the latter there is a regularly formed cuticle on both surfaces, which is perforated by openings of a peculiar nature, and which do not exist in the former. This difference of structure is in direct relation with the respective functions of aerial and submerged leaves, and with the respiration of plants.

The same formation which prevails in the trunk and branches of a tree is also recognised in its leaves, only that the structure in the former is annular and concentric, and in the latter spread out over an extended plane surface. The spiral vessels and sap vessels, which are observable in

the leaf-stalk, are also partly to be traced in the leaf, and form the nerves and veins, which may be considered as the skeleton of the leaf. The spaces between them are filled with a cellular substance, covered by a soft, yet firm cuticle. The cellular substance and the cuticle are different on the upper and the lower surfaces; and, however various the form of the leaves, much conformity always exists in this respect, and is intimately connected with the life of the plant.

The leaf is not only valuable as an organ of respiration, but it is the primary agent in the process of perspiration. There is a curious fact recorded by Dr. Hales which will tend to shew the amazing amount of perspiration which results from the surface of a large leaved plant. He says, that the *Helianthus annuus*, or large annual sun-flower, gave off nearly two pints of water in the course of twelve hours. In a wet night, on the contrary, the same plant actually gained about three ounces in weight. The surface of the plant compared with that of its roots was, as nearly as could be calculated, in the proportion of five to two; therefore, the roots must have imbibed moisture from the earth in the same proportion, or the plant would have faded.

The mere frame-work of a leaf* is a perfect wonder in natural architecture, and the fibrous matter which forms the basis of its structure is so arranged as to give the greatest possible support to its extended surface.



An examination of the *thorn* and *prickle* should succeed our view of the leaf. These appendages

* There are few natural history objects more important in a microscopic point of view than the dried anatomical preparation furnished by a common leaf. In the above figure the sketch has been procured by merely macerating the vegetable in water; but the lace back forms a still more accessible object; and the author of this work has often, in his public lectures, exhibited its exquisitely reticulated structure when spread out on a screen to shew the vast superiority of the frame-work of nature over the handy-work of man.

appear like natural *cheval de frise* for the protection of those plants with which they are studded. The first of these grow from the woody substance of the plant. They are very distinctly marked in the buckthorn, and in that case protrude from the stem and branches; but in the holly and some other plants they proceed from the leaves, whilst the calyx of the thistle is richly dight with their mimic blossoms.

Now the prickle, instead of proceeding from the woody part of the tree, arises from the bark, of which a sufficient example may be adduced in the rose; and when we speak of the natural sweets of that plant finding a drawback in the thorns which surround it, we must consider the assertion rather as a poetical fiction than as a physiological truth.

The *stipules* are very curious portions of a plant. They consist of small foliaceous appendages, accompanying the real leaves, and assuming the appearance of leaves in miniature. If we examine a stalk of heart's-ease there will be found at the base of each leaf-stalk a pair of small leaves very different from the real leaf, and these are the stipules.

Another very important appendage to a plant

is the *floral leaf*. This leaf generally differs from the true leaf both in shape and in colour; and is commonly situated on the flower-stalk, and often so close to the corolla as to be mistaken for the calyx. As the stipule is an appendage to the leaf or leaf-stalk, so the bractea is an accompaniment to the flower, or flower-stalk. The bractea is very perfectly seen in the lime, and the lavenders have coloured bracteæ.

As many plants are too weak to support themselves, there is a beautiful natural provision by which they are enabled to ascend and acquire the requisite portion of light and heat, which must now be adverted to. The *tendril* forms an important feature in the mechanism provided for this purpose. It consists of a fine spiral fibre, proceeding from different parts of the plant, by means of which it attaches itself to some other plant or body for support. The tendril is not convoluted at first, as it shoots out in a straight direction, but it soon commences twisting; and if it does not immediately find a body to attach itself to, it assumes a very beautiful appearance, its folds lying in contact with each other, and gradually contract into the form of a hollow cone. One of the most elegant plants to which the

tendril forms a natural appendage, is the passion-flower.

Climbing plants always form a beautiful feature in picturesque scenery. What traveller can trace the richly foliaged pyramids of a Kentish hop-garden without feeling that in point of luxuriance it far exceeds the much boasted but arid plains "rich with the vintage of southern climes." The means by which this interesting class of plants raise themselves up, so as to offer their flowers to the sun, are as various as they are curious. Thus we find the ivy and bignonia ascending by the help of little fibres, which fix themselves to the bark of trees or the crevices in walls so tightly as to render their disengagement a difficult task without injury to the body that supports them.

The honeysuckle and the hop twine themselves round the trunk or branches of a tree so tightly as to make a deep impression on the hardest timber, which they effect by resisting the natural expansion of the tree. Again, we find the vine provided with the most beautiful cork-screw tendril, which, though delicate and highly elastic, retains its hold most perfectly, forming a species of gordian knot which it is easier to cut than to untie. Last, though not least, in this

chain of parasitic wonders, we may place those plants which are provided with a sort of hook in their leaf-stalk, similar to that on the wing of a bat, and equally useful.

While speaking of the tendrils of a plant, by which it is enabled to support itself in those cases in which the stem is too weak for its own support, we must not omit to notice the beautiful provision by which plants, even those unprovided with tendrils, are enabled to direct their serpentine course round any other body within their reach. These volutions are not in the same direction in all plants, and there is little doubt but what it is produced by the original spiral arrangement of the fibres of the stem.*

A very common mode of protecting the interior of the corolla in climbing plants is to place the flowers on an elastic pendulous footstalk, which gives way before the wind, and, turning like a weathercock from the breeze charged with rain

* "Some climbers support themselves by the reflexed position, or twisting character of their petioles, and others by the paw-like form and insinuating processes of their clinging fibres. Spiral tendrils convolve first one way for about half their length, and afterwards the contrary way."—MAIN's *Illustrations of Vegetable Physiology.*

or sleet, offers only a solid and well-protected side to its attacks.*

The various parts of a plant which we have been considering are in reality but supplementary to the perfection of the *fruit*, to which we must now direct our attention. It is this which gives a species of perpetuity to the vegetable kingdom,

* Thus, for instance, we find a field of peas propelled in a new direction by every change in the blast; and though, as in the first of the above sketches, the plant presents a series of faces in opposition to each other when the air is at rest, yet the blast will immediately propel them, or the blossoms of any other equally flexible plant, in such a direction as to protect the interior of the corolla from injury, as is shewn in the next view.

and makes it not unaptly a type of our own immortality, as a plant, though formed of the simplest materials, brought together from its parent earth, contains within itself a living principle, which, even after the apparent extinction of life, puts forth new blossoms, and has a new resurrection at each return of spring.

Fruits differ as much in their flavour and nutritive properties as they do in their external appearance, as some are exceedingly well fitted for the support of animal life, whilst others are immediately destructive of existence ; but yet

> "How useful all! how all conspire to grace
> The extended earth, and beautify her face;"

for many of the most deadly vegetable poisons form the most valuable remedies in the healing art; and it is a well-authenticated fact, that more than a third of the whole human race are entirely supported by the fruits of the earth.

While speaking of the value of the vegetable kingdom as the great support of animal life, we must not omit to notice its importance to the feathered tribes who deck the fair face of nature. The leafy foliage of most plants furnishes a shade to the "fowls of the air," and their labours in the early months of summer serve to protect the

young birds from the attacks of myriads of insects who would otherwise destroy them. In the winter months, Nature, who, even in her severest mood, is never neglectful of her offspring, has provided an abundant supply of berries which, by their peculiar colours, are rendered distinctly visible in the midst of the heaviest snows of our climate. Under this head we may place the

> "—— Berry-bearing thorns,
> That feed the thrush."

The beautiful scarlet haws found on the hedges furnish an excellent repast, not only for the bird that the poet has named, but for myriads of these tiny choristers. The same may be said of the privet, which is, in its season, richly dight with clustering bunches of deep purple-coloured berries. These are especially sought after by the bullfinch and thrush, and the branches form an admirable

> "Dwelling for the feathered throng
> Who pay their quit-rents with a song."

The maturation of fruit forms a very interesting feature in the phenomena of vegetable life. If all fruits acquired their maturity at the same period of time, they would lose much of their present value as an article of food; as the earth

would be overloaded with its produce at one period, and at another a general dearth would be experienced. Indeed, plants exhibit as much diversity in the length of time necessary to ripen their fruit, as in the periods at which they put forth their blossoms. As a general rule we find that those plants which blossom in the spring present their ripened fruits in summer; and if they blow in summer, the harvest may be expected in autumn; whilst the winter fruit is indicated by autumnal blossoms. To this law we find, however, many exceptions, of which the hazel-tree may serve as an example. Its blossoms appear in February, whilst the fruit is not presented in a ripe form till the autumn.*

According to M. Couverchel, two periods may be distinctly marked in the progress of fruit. The first comprehends its developement and the formation of the principles which enter into its com-

* Many suggestions have been offered for the formation of a *Calendarium Floræ,* none of which have been based in much practical experience; and, even if we suppose the best data to be procured for one season, they may be entirely valueless in the succeeding one, as a difference in the temperature or hygrometric character of the air, will frequently cause a difference of days, or even weeks, in the period of the harvest.

position; and, during this initiatory period, the influence of the plant upon the fruit is indispensable. The second comprehends the ripening, properly so called, and is effected by the reaction of the constituent principles of the fruit. During this latter period, the acids contained in the plant, favoured by heat, transform the gelatine into saccharine matter. The phenomena are in this case purely chemical, and independent of vegetable life. In accordance with this view, he recommends as a general principle that fruit should be finally ripened subsequently to their removal from the tree,—a practice that has long been adopted with particular kinds of fruit.

We have already seen that a knowledge of plants implies something more than an acquaintance with their external characters, and their scientific classification. The vegetable kingdom furnishes the chemist with some of the most interesting bodies for analytical research; and, by copying the processes which the naturalist sees carried on in the great laboratory of nature, he is enabled to prepare a variety of substances which were previously considered of a purely elementary character. Thus the mutual connexion between these sciences has led to a new branch of natural

history, which may not unaptly be termed the chemistry of vegetable life.

In the growth of plants, a striking analogy to that of animals is observable. This circumstance has already been adverted to, but the similarity is so striking, and it is so illustrative of the present part of our subject, that it may be advisable to examine it more in detail. Thus, the root serves the purpose of a stomach, by imbibing nutritious juices from the soil, and supplying the plant with materials for its growth. The sap, or circulating fluid, composed of water holding in solution saline, mucilaginous, saccharine, and other particles, rises upwards through the wood in a distinct system of tubes, which correspond in their office to the lacteals and pulmonary arteries of animals, and are distributed in minute ramifications over the surface of the leaves. In its passage through this part of the plant, the sap is exposed to the agency of light and air, experiences a change, by which it is more fully adapted to the wants of the vegetable economy, and then descends through another system of tubes, yielding, in its course, all the juices and principles peculiar to the plant.

The sap of different trees varies very consider-

ably, both in its quantity and constituent elements; and, referring to its various offices, the poet emphatically exclaims,—

> "Mark, too, the sap, that, ere its process ends,
> In course, alternate, rises or descends;
> In active virtue, how its liquid power
> Creates the wood, the leaf, the fruit, and flower."

We have seen that plants absorb carbonic acid from the air, under certain circumstances, and emit oxygen in return. When a healthy plant, the roots of which are supplied with proper nourishment, is exposed to the direct solar beams in a given quantity of atmospheric air; the carbonic acid, after a certain interval, is removed, and a given volume of oxygen is substituted for it. If a fresh portion of carbonic acid is supplied, the same result will ensue. But this change only takes place in the sunshine: in the dark, an opposite effect takes place; oxygen disappears, and carbonic acid is evolved. In the dark, therefore, vegetables deteriorate rather than purify the air, producing the same effect as the respiration of animals.

With respect to the food of plants, the chief source from which they derive the materials of their growth, is the soil. However various the

composition of the soil, it consists, essentially, of two parts, so far as its solid constituents are concerned. The first is of a purely earthy character, such as siliceous earth, clay, lime, and sometimes magnesia; and the other is formed from the remains of animal and vegetable substances, which, when mixed with the former, constitute mould. A mixture of this kind, moistened by rain, affords the proper nourishment of plants. The water percolating from above dissolves the soluble salts with which it comes in contact, together with the gaseous, extractive, and other matters, which are formed during the decomposition of the animal and vegetable remains. In this state it is readily absorbed by the roots, and conveyed as the sap to the leaves, where it undergoes the direct process of assimilation.

Without water, plants speedily wither and die. It gives the soft parts that degree of succulence necessary for the performance of their functions, and affords the two important elements, oxygen and hydrogen, which, either as water, or under some other form, are contained in all vegetable products. So carefully, indeed, has nature provided against the chance of deficient moisture, that the leaves are endowed with a property both

of absorbing aqueous vapour directly from the atmosphere, and of lowering their temperature during the night by radiation, so as to cause a deposition of dew upon their surface, in consequence of which, during the driest seasons, and in the warmest climates, they frequently continue to convey this fluid to the plant, when it can no longer be obtained in sufficient quantity from the soil.

When plants are incinerated, their ashes are found to contain saline and earthy matters, the elements of which, if not the compounds themselves, are supposed to be secreted from the soil. Some experiments, however, would seem to lead to a different conclusion. Several kinds of grain, such as barley, wheat, and rye, were sown in pure flowers of sulphur, and supplied with nothing but air, light, and distilled water. On incinerating the plants thus treated, they yielded a greater quantity of saline and earthy matters than were originally present in the seeds. Now these results can be accounted for only in two ways. It may be supposed, in the first place, that the foreign matters were introduced accidentally from fine particles of dust floating in the atmosphere; or, secondly, it may be conceived, that they were

derived from the sulphur, air, and water with which the plants were supplied. If the latter opinion be adopted, we must infer that the vital principle, which certainly controls chemical affinity in a surprising manner, and directs this power in the production of new compounds from elementary bodies, may likewise convert one element into another. This curious investigation more properly, however, belongs to the researches of the analytical chemist; and we may proceed to examine some of the more important constituents of plants as they are separated in nature's laboratory.

The vegetable kingdom produces some of our most valuable aromatic drugs; and the scent of plants is a subject too interesting to be passed without a brief notice. The great Parent of Creation has not only made all nature

> " —— Beauty to the eye,
> And music to the ear;——"

but has also endowed a large portion of the vegetable kingdom with odours of the most attractive kind. These are usually produced by a volatile essential oil; and it is also somewhat paradoxical that, though the essential oil will not, under ordinary circumstances, combine with common water,

yet its odours are readily imparted to the atmosphere when that has become moist with rain. Thus the genial shower which revivifies the natural tints of plants, also tends to render their odours more delightful to the senses.

The greater part of those trees which afford spice, and which are peculiarly valuable for their aroma in an economical point of view, are natives of the East, and especially of the Indian isles; and the only remarkable exception is that of the allspice, or pimento, the fruit of a tall and fragrant species of myrtle growing wild in the West Indies.

Cinnamon, which is one of the most valuable of the East Indian spices, forms the inner bark of the *laurus cinnamomum*, a tree nearly allied to the common bay, and its leaves produce the oil of cloves, so much in request for medicinal purposes.*

* One passage from Herodotus will shew how extremely ignorant the ancients were of the mode of the real climatal site of this now well-known vegetable product. "How or where this substance grows," says Herodotus, "I have not been able certainly to ascertain; but, from the best information I can get, it appears to be the produce of those countries in which Bacchus was nursed. It is said, that in Arabia great birds bring this wood (which we, after the Phœnicians, call

Resins are substances which exude from many trees, either from natural fissures or artificial wounds. Common resin, or "rosin," as it is called, is obtained by distilling the exudation of different species of fir, in which case oil of turpentine is distilled off, and the resin remains in the alembic.

The semi-fluid resin, called Venice turpentine, is procured from the larch, and is obtained by making incisions in the trunk of the tree a few feet from the ground. Narrow troughs suspended beneath these apertures convey the resinous juice into large receivers beneath; and a single tree will produce from eight to ten pounds of the turpentine.

This valuable application of the larch was well known in ancient times, as we find the grief of the daughters of Clymene, after their conversion into a living grove, thus described by the poet Ovid:

cinnamon) into their nests: these nests are constructed of clay, and fixed against the faces of steep cliffs, out of the reach of human feet. The Arabians, in order to obtain the spice, carry the limbs of oxen and asses, and other large animals, near the nests, and there leave them; when the birds fly down and carry up the meat, whose weight breaks down the nests, and brings them to the earth."

> "The new-made trees in tears of amber run,
> Which, hardened into value by the sun,
> Distil for ever on the streams below:
> The limpid streams their radiant treasure shew."

Wax is also a valuable vegetable product. It exists in many plants, and may be obtained by bruising and boiling them in water, when the wax separates, and may readily be collected after it is cold. The berries of the common candle-berry-myrtle,* and the leaves and stem of the ceroxylon, afford considerable quantities of wax by this process. The glossy varnish upon the upper surface of the leaves of many trees is of a similar nature; and nearly resembles the wax formed by the active inhabitant of the apiary.

We may next examine the character of *manna*, which is a very interesting vegetable product. The first notice we find of this substance occurs in the Holy Scriptures, where the term is employed especially to designate a miraculous kind of food, which fell from heaven, for the support of the Israelites, in their passage through the wilderness. Manna is found in great abundance on the ash, but it is in no shape confined to that tree. Mr. Swinburn states, that in Calabria the gatherers of

* *Myrica cerifera.*

manna commence their operations in the month of July, by making a deep horizontal incision in the stem, and suspending a concave leaf beneath to catch the semi-fluid manna as it oozes forth. It is still used as an article of food both in Asia and America; but in Europe manna is only employed as a medicine.

Sugar is the last vegetable product to be noticed, and this, from its many valuable properties, has almost become a necessary of life. It may be extracted from the juice of a number of vegetables; but that which is usually employed is obtained from the common sugar cane.* It also exists in large quantities in the sugar maple;† in the manna ash,‡ and in the root of the beet. In many ripe fruits sugar is a predominating ingredient; and in dried grapes and figs it is often seen as a superficial incrustation. Most flowers produce a sufficient supply of saccharine matter to tempt the roving and industrious bee to their luscious and richly stored nectaries; but the jasmine contains it in the highest perfection, and where the

"—— Jasmines spread the silver flower
To deck the wall or weave the bower,"

* *Saccharum officinarum.* † *Acer saccharinum.*
‡ *Fraxinus ornus.*

there will the treasure seeker be found most actively engaged. This alone should be a sufficient argument for the more general cultivation of this beautiful plant, to say nothing of the odour-clad sweets that they pour forth as an evening offering to the great Giver of all good; and forming a hymn of thankfulness even when man, with all his boasted knowledge, has his senses closed in sleep. But there are many other plants now but little heeded, which might be advantageously cultivated, not merely for their saccharine properties, but also for their general usefulness. "For nature—exhaustless nature," offers treasures of which the human race have as yet availed themselves only to a very limited extent. Plants that were formerly considered but as insignificant weeds, are now known to possess medicinal properties of a high order; whilst others that, within the memory of man, were considered but as cumbering the ground, are found to contain the most nutritious and wholesome products. Truly, indeed, may those who study the workings of nature as they are exhibited in the structure and economy of the vegetable kingdom exclaim, with the wisest of old, "How perfect are thy works, O Lord!"

DESCRIPTION

OF

THE GRAPHIC ILLUSTRATIONS

TO THE PRECEDING

LECTURES ON BOTANY,

*Which may be procured of the Publisher without this volume.**

Group of Lilies.

There is no plant better fitted to illustrate the primary parts of fructification than the one exhibited in this sketch. The flowers are so arranged as to shew the situation of the pistil and stamens with reference to each other, and as such, to illustrate the basis of the Linnæan classification. Six stamens and one pistil shew that the plant belongs to the class and order *Hexandria monogynia*, and the falling pollen is distinctly marked on the white petal beneath.

Roots of Plants.

A very large proportion of the plants that are found on our globe are tenants of the earth. It is true that

* See Introduction to the work.

many float on or under the surface of the waters, and others are found parasitic on their neighbours of larger growth; these, however, form but the exceptions to a law which has given the earth as a fixed abiding place of the vegetable kingdom, and has adapted the plants by their decomposition for the fertilisation of the earth, as well as the earth for the support of vegetables. They differ, however, considerably in their form and structure. In this graphic delineation we have representations of the tuberous root, the bulbous root, the granulated and knobbed forms, and, lastly, the spindle-shaped root.

Root of Superb Lily.*

From this species of rough and apparently valueless stem, proceeds that elegant plant which is so frequently met with in our flower-gardens,—the lily. It is a casket which contains innumerable germs of life, as the root may be divided into a number of separate parts, each of which will, if time be allowed, vegetate like their common parent. In the language of botany it is called a scaly formed bulbous root, and the descending fibres depicted in the view serve to procure nourishment from the soil in which it vegetates, to which they also serve to attach it.

* Class and order, *Hexandria monogynia.* Nat. family, *Liliaceæ.*

Inflorescence of Spring.

The plants here delineated form beautiful harbingers of the coming floral season. They are shewn soon after they have quitted their winter habitation, and just risen from their enveloping mantle of snow. The crocus * is peculiarly celebrated for the vivid hues of the blue and yellow varieties, the former of which ripens its seeds earliest. The snowdrop, † though less vivid in its petals, is equally attractive for the delicate simplicity of its pendent flowers.

Water Lily. ‡

Each element has its own proper vegetable inhabitant; and there are few more beautiful residents of the waters than the flower here delineated. The blue water lily is not so large as the white, which is crowded with petals ; but as an aquatic plant this is by far the handsomest specimen.

Auricula. §

In this mode of inflorescence a series of partial

* Linnæan class and order, *Triandria monogynia.* Nat. order, *Irideæ.*

† *Galanthus nivalis.* Linnæan class and order, *Hexandria monogynia.* Nat. order, *Amaryllideæ.*

‡ Linnæan class and order, *Polyandria monogynia.* Nat. order, *Nymphæceæ.*

§ Linnæan class and order, *Pentandria monogynia.* Nat. order, *Primulaceæ.*

footstalks take their origin in a common stem, which, instead of bestowing a " wood of leaves," furnishes one of flowers. The *primula*, to which genus the auricula belongs, derives its title from its being the earliest to put forth its flowers. It is a native of the principal Alpine regions of southern Europe, and is also found in some parts of the East.

Strawberry.*

We have here exhibited the fruit and flower, as well as the richly ornamented foliage of the strawberry, and the modesty of its blossoms with their delicate white petals pleasingly contrast with the richly tinted fruit.

Group of Hyacinths.†

The bulbs which bear these wax-like flowers are singularly well fitted to illustrate the physiology of this species of plants, as the may be seen to put forth their fibrous roots in the water; and the process of vegetation may thus be traced without interfering with the growth of the plant. The hyacinth bulb placed in its transparent glass, containing good river water,

* Fragaria. *Icosandria polygynia.* Linnæus. Nat. order, *Rosaceæ.*

† Hyacinthus. Linnæan class and order, *Hexandria monogynia.* Nat. order, *Asphodeleæ.*

thus becomes a valuable addition to the study of the wonders of the vegetable kingdom.

The Passion-Flower.*

In our graphic sketch this plant is seen resting against a column, round which it twines and spreads forth its delicate spiral tendrils. Every variety of the passion-flower is beautiful ; but the one we have here represented is peculiarly so. It is furnished with a quadrangular stem ; and in the engraved title to this work there is another view of the same plant, shewing the external parts of the flower. The same plate contains two other very beautiful varieties of the passion-flower.

Tulip.†

We have in this case delineated the expanded petals of the tulip for the purpose of exhibiting the structure of the flower and the primary organs of fructification ; and, as in the case of the lily, the stamens and pistil are distinctly portrayed.

The Arum.‡

This plant is interesting from the character of its

* *Monadelphia pentandria* of Linnæus. Nat. order, *Passifloreæ.*

† *Hexandria monogynia*, Linnæus. Nat. order, *Liliaceæ.*

‡ *Monœcia polyandria* of Linnæus. Nat. order, *Aroideæ.*

flower, and also for its peculiar changes of temperature. The latter feature is found in all the arums, though most distinctly marked in the common arum.* Its greatest elevation of temperature occurs just as the spatha or sheath is about to open. The spadix or spike, which is beautifully protected from the inclemency of the weather by the sheath, is afterwards equally advantageously placed for the reception of light and heat; and one of the earliest results of their joint action is a speedy change of colour. Our sketch represents the plant a few days after the opening of the spatha.

Group of Carnations.†

Divine honours were at one period paid to this celebrated plant, and enormous sums have been given for it even in modern times. We have selected the fullest form of the flower, as the one best fitted to illustrate the genus *dianthus*.

Group of Fruit.

That Nature is an indulgent " nursing mother" is in no shape more fully illustrated than in the endless variety of fruits that are exhibited on the face of our

* *Arum maculatum.*

† Belonging to the Linnæan class and order, *Decandria digynia.* Nat. order, *Caryophylleæ.*

globe. Some are especially adapted for solid nutriment, whilst others form the most exhilarating beverages; and each clime produces the fruits best fitted for the peculiar wants of its inhabitants. In this group we have delineated a section of the pomegranate, with its seeds embedded in a species of nectiferous pulp; the fig containing a series of florets, which with their receptacle form the fruit,—and the nut with its bony case, which is especially valuable from its capability of being preserved as an article of food in every season of the year.

Group of Bog Plants.

Trees, shrubs, and herbs, are mostly terrestrial; but there is a tribe of plants, and of different genera, which constantly inhabit bogs. Some of these are extremely curious, and many are very beautiful. Notwithstanding the constant humidity of their natural station, many of them are furnished with leaves formed into hollow pitchers, which are always more or less filled with limpid water; as if they were provisional reservoirs against accidental drought. Of these the Sarracenia, Nepenthes, and Cephalotus, are examples.

Group of Cryptogamic Plants.

The fungi are usually considered as forming one of the last links in the scale of vegetable life. Here, however, we find an abundant supply of nutritious and

richly flavoured food for man, and some of the lower orders of the animal kingdom. The fungi cannot properly be said to have any herbage, but they are furnished with a pileus, or cap, which serves to carry on the process of vegetation, whilst the elegantly formed columnar stem elevates it from the ground, and gives the plant the joint advantages of light and air.

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LONDON:
Printed by J. Moyes, Castle Street, Leicester Square.